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BROODING AND REARING CHICKENS

W. E. NEWLON and V. S. ASMUNDSON

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CONTENTS

PAGE

Introduction 3
Brooding the chicks 4
General requirements 5
Floor brooding 8
Houses 8
Yards 11
Shade 13
Electric brooders 13
Gas brooders 16
Oil stoves 16
Coal stoves 16
Hot water and hot air 16
Fireless brooders 17
Other brooder-room equipment .. 17
Brooder management 18
Outdoor brooding 19
Brooders 20
Feeders and waterers 21
Management 21
Battery brooding 22
Housing requirements 22
Battery brooders 23
Management of battery brooders 24
Renewing the flock 25
Season for brooding 25
How many chicks to brood 27
Sources of stock 27
Straight-run vs. sexed chicks ... 29
Feeding 29
Brooder vices 31
Diseases and parasites of chicks ... 33

PAGE

Rearing pullets 34
Range vs. confinement 34
Size and kind of yards 35
Dirt yards 35
Wire porches 36
Concrete yards 36
Slat yards 37
Feeding and management 37
Diseases and parasites of young birds 40
Grading and segregation 40
Segregation out of the brooder house 41
Segregation into laying house .. 42
Protective devices 43
Rearing cockerels for breeding 45
Numbers required 45
Selection and culling 45
Feeding and management of breeding cockerels 46
Dubbing and spur removal 46
Rearing meat birds 47
Economic considerations 48
Costs and returns 48
Seasonal effects 49
Breeds and crossbreds 50
Houses, yards, and equipment 51
Management of meat birds 52
Feeding meat birds 52
Vices and blemishes 54
Grading and disposal 55

BROODING AND REARING CHICKENS[1]

W. E. NEWLON[2] AND V. S. ASMUNDSON[3]

INTRODUCTION

THE AVERAGE annual farm income from poultry on California farms equals approximately $40,000,000. The combined income from chickens and chicken eggs represents about 75 per cent of this amount, and it is also about 15 per cent of the total farm income from livestock.

Data from the 1940 Census indicate that chickens were kept on 73,811 California farms and that 24,750,000 chicks were raised on these farms during 1939. Census data also show that 50 per cent of the chickens in this state are found in flocks of 1,000 birds or more. These figures prove that the poultry industry is of great economic importance in California and that poultry raising is a major industry on many farms.

Wherever chickens are raised on a commercial scale, artificial brooding of some kind will be used extensively. Good brooding, rearing, and management can be made to bring out the best qualities inherited by a chick. On the other hand, poor brooding and rearing can, and often does, ruin good chicks. It is most important, therefore, for poultrymen to use adequate brooder equipment and to employ good brooder management.

The ability to raise chicks of good quality is one of the most important factors in the management of a successful poultry enterprise. Many poultrymen fail in this, and nothing will ever make up for poor results experienced during the growing period. Best results require adequate equipment, some practical knowledge, plenty of common sense, and much hard work.

The production of chickens and eggs for human consumption tends to be a specialized industry in California. Probably no farm practice has changed more during recent years than have the methods employed in brooding and rearing chickens. The information in the following pages is based on experience, reports and literature, observations in the field, and experimental work in the California Agricultural Experiment Station.

Location with Respect to Available Land.—When considering the location for brooding and rearing chicks many factors need to be con-

[1] This circular supersedes Extension Circular 28, *Brooding and Pullet Management*, by W. E. Newlon and M. W. Buster.

[2] Specialist in Agricultural Extension.

[3] Associate Professor of Poultry Husbandry and Associate Poultry Husbandman in the Experiment Station.

sidered. The amount of land available, as well as the type of soil, lay of the land, and the presence or absence of good water drainage, should each influence the method or system of brooding and rearing selected. Very hilly land is always undesirable because of difficulties in house location and construction, as well as in flock management.

When dirt yards are to be used, low flat lands are usually objectionable. During the rainy season, heavy clay or adobe soils often present serious problems. But if the chosen system provides for raising the birds without contact with the ground, type of soil is of no consequence and poor drainage is a mere inconvenience.

All other things being equal, the most ideal location for brooding is on a slight slope with a southern exposure. The soil on a south slope during winter and spring will be warmer than the same type of soil on any other slope or on the level. Because it is warmer it is also drier.

Good air drainage is equally important. Since cold air settles to the bottom, small, enclosed valleys should be avoided whenever possible.

Location with Respect to the Whole Poultry Layout.—The location of permanent brooder houses should fit well into the general farm plan with respect to other buildings and the routine of good poultry management. Chicks should be segregated from adult poultry and all other farm animals. Proximity to water supply and feed storage rooms is important, but excessive shade from other tall farm structures or trees may be objectionable.

In starting a new poultry enterprise, considerable thought should be given to the mutual relations of the proposed buildings. Their systematic arrangement with reference to their respective purposes, convenience, and reducing to a minimum the distances traveled in caring for the birds, is an important means of holding down labor costs. Due regard should also be given to the possibilities of future expansion.

When dirt yards are used for chicks, these should be so located that drainage from yards used for adult poultry cannot bring contamination which will be a source of danger to the chicks.

BROODING THE CHICKS

The brooding period extends from the time the chicks hatch until they no longer require artificial heat—usually 4 to 8 weeks, according to the weather and the way the birds feather out. When low temperatures prevail it is advisable to continue artificial heat until the birds are well feathered and roosting; when the weather is hot, artificial heat may be discontinued much earlier.

The objective of brooding is to raise the chicks hatched. Success or failure is best measured by the percentage of well-grown and feathered,

normal, healthy birds that survive to the end of the brooding period. Rapid growth of birds raised for meat production is desirable; equally rapid growth of pullets to be kept for egg production is not necessarily desirable. On the other hand, a subnormal rate of growth is always undesirable since it indicates poor stock, poor management, disease, or inferior feed.

Three general types of brooders have been devised for meeting these objectives. These are the floor brooder, the outdoor brooder, and the battery brooder. They will be discussed more fully in following sections.

GENERAL REQUIREMENTS

Chicks require an environment that will enable them to grow and thrive. An environment in which the chicks grow and thrive satisfactorily, as judged by present standards, is not necessarily the optimum environment. There are still so many gaps in our knowledge that the optimum requirements under all conditions cannot be stated. No serious difficulty is caused by this lack of knowledge with floor- and outdoor-brooding systems because, while temperature must be carefully regulated, wide fluctuations in some of the environmental factors, such as humidity, apparently have little effect. When chicks are battery-brooded, a more precise control of humidity and other environmental factors is usually considered necessary.

In practice, the environment of floor- or outdoor-brooded chicks varies, being different at night from what it is during the day—also varying with climatic conditions and according to the brooding system used. In air-conditioned rooms the environmental conditions are more uniform. The environmental conditions provided should be those found to be economical in costs of housing, equipment, fuel, and labor, consistent with satisfactory growth and low mortality.

Heat.—Heat is the only factor in the physical environment of the chick that is controlled with reasonable accuracy and then only under the brooder or in the brooder compartment, except in air-conditioned battery rooms. If the temperature cannot be reasonably accurately controlled, dependable results are not to be expected.

The temperature in the space occupied by the chicks when they settle down for the night should be about 95° F for the first few days. It may be lowered as the chicks grow older, but should be maintained at a point where the chicks are comfortable and can get warm quickly in cold weather.

Chicks after the first few days will stand a wide range in temperature from about 70° to 125° F for short periods without dying from the effects. If the temperature is too low, the chicks will huddle; some may

be smothered and die, while others will become stunted; those that grow well will make inefficient gains in terms of pounds of feed per pound of gain. Diarrhea has also been observed as a result of chilling where sudden changes in temperature were produced with the aid of a fan. Chilling also increases mortality from infectious diseases such as pullorum disease, paratyphoid, or coccidiosis, but mortality from these diseases will not occur unless the causative organisms are present. On the other hand, if the temperature is too high, the chicks are uncomfortable, pant, hold the wings away from their bodies, and remain comparatively inactive; rate of growth is slow and inefficient, and mortality is likely to be high.

The temperature in the brooding compartment can usually be lowered 3° to 5° F each week as the chicks grow older until heat is discontinued. The heat is best regulated according to the reactions of the chicks. A reliable thermometer should be used, but do not place sole reliance on temperature reading, since the actions of the chicks are the best guide to the temperature required.

Safety from fire must be considered when selecting brooding equipment. The heating equipment should be so constructed that there is a minimum fire hazard. Furthermore, safe heating equipment may become a fire hazard unless kept in good repair. Unless the brooding equipment is reasonably fireproof, the entire brooder house with its content of chicks and equipment may be lost. The average cost of fuel varies from about 1 to 5 cents per chick. The cost of fuel is, therefore, a small item in the cost of raising pullets and is one of the minor factors in the cost of raising fryers. The needs of the chicks for adequate ventilation and space should, therefore, not be sacrificed for unimportant savings in cost of fuel. Nevertheless, the availability, dependability, and cost of fuel all require careful consideration before deciding upon a brooder system.

Ventilation.—One hundred chicks require about 2 cubic feet of air per minute to support maximum growth for the first few weeks (see table 3). This amount of air flow will not keep the brooder dry after the first 3 weeks, nor will double this amount (4 cubic feet per minute for 100 chicks) keep an enclosed brooder dry for the first 6 weeks.

Fresh air is important to the health of the chicks. Too rapid air movement, however, which causes the chicks to be uncomfortable, should be avoided. When chicks are floor-brooded there is usually so large an air volume that insufficient ventilation is not likely to be a limiting factor. Yet it is undoubtedly true that there is more frequently too little than too much fresh air. To avoid difficulty from this cause, neither the house nor the brooding compartment should be closed tight when natural ventilation is relied upon. This is particularly important if oil-, coal-, or gas-burning brooders are used, since there is some danger of carbon

monoxide poisoning. Furthermore, forced ventilation should be provided for large, curtained electric brooders and for rooms equipped with battery brooders.

Humidity.—It has been demonstrated that relative humidity, ranging from approximately 40 to 73 per cent, has no apparent effect on floor-brooded chicks. High humidity may increase the moisture content of the litter and thereby provide an ideal place for coccidia and other disease-producing organisms to live. Heat and ventilation should, therefore, be used to control humidity.

Space.—The brooder should be large enough to provide a comfortable place for all the chicks without crowding. In electric brooders at least 7 square inches of floor space should be allowed under the hover for each chick. More space should be allowed after the first week or two. With stove-type brooders having the canopy suspended at a distance above the floor, it is less important to use a certain size of canopy for a given number of chicks, but the size of the brooder stove and canopy should be approximately in proportion to the number of chicks and the size of the brooder room. With the stove type of brooder, the chicks will settle in a circle at the distance from the stove which they find most comfortable. If a large stove or too much heat is used in a small room, the chicks are likely to crowd to the walls and into the corners with disastrous results.

Labor Efficiency.—Three main factors usually affect labor efficiency in use of the brooder. These are (1) the extent to which the temperature is automatically controlled, (2) the ease with which temperature can be adjusted, and (3) the ease with which the brooder can be operated. In order to meet these requirements the brooder must be capable of developing as much or as little heat as is required and must have adequate means of controlling the temperature. These two essentials of a good brooder are often sacrificed to save on first cost or merely because they are overlooked. Many otherwise satisfactory brooders require frequent adjustment as weather changes and as the chicks get older. This is true, for example, of overhead-contact brooders, in which the height of the heated surface (cloth, rubber, or feathers) is regulated to the size of the chicks. Some brooders are so constructed that they collect dirt; others are difficult to clean and keep clean. The brooder and everything pertaining to it should be easy to clean, and thus leave the poultryman with a maximum of time for the routine management of the chicks. Careful management is required to keep the chicks growing, healthy, and free from vices. Anything that unnecessarily increases labor will make the successful brooding of chicks that much more difficult.

FLOOR BROODING

Floor brooding is the most widely used and adaptable of the various systems for brooding chicks.

For chicks brooded on the floor a suitable house, brooders, and other equipment are required (fig. 1). Yards may or may not be used.

Houses.—Practically all types of poultry houses have been used to brood chicks, but many of them are not suitable. Any *good* poultry house

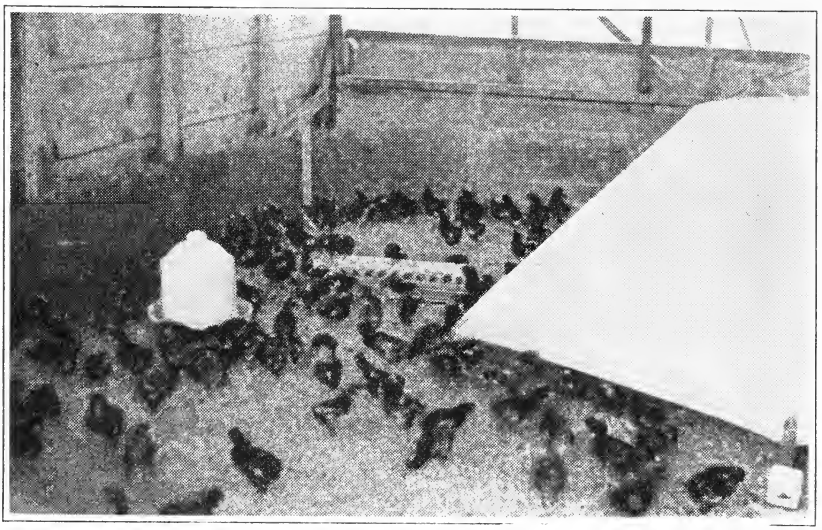


Fig. 1.—Floor brooder with guard fence moved away from the canopy to give the chicks more room.

can be satisfactorily used. A good brooder house must be so ventilated that it will provide adequate fresh air without excessive drafts; provide ample floor space for the chicks and headroom for the attendant; be well lighted; dry; well planned so as to facilitate routine work, especially cleaning; durable and reasonably rodent-proof, yet economical to construct.

A house that is adequate in one area may be entirely unsuitable elsewhere. Thus, wire-walled houses (figs. 2 and 3) are best adapted to use in some districts where high winds are not experienced and where there is little rainfall. Such houses are unsuitable in many parts of the state since they give little protection against wind, rain, or cold. A house that is suitable for use in all parts of the state is illustrated in figure 4.[4] Such

[4] For information about housing, see: Dougherty, J. E., and H. L. Belton. Poultry houses and equipment. California Agr. Exp. Sta. Bul. 476:1–77. Revised 1940 by H. L. Belton and V. S. Asmundson.

a house is economical to build when durability, ease of operation, and the protection it affords both the chicks and the attendant are considered.

About 50 square feet of floor space should be allowed for each 100 chicks (table 1). The recommended floor areas for different-sized broods

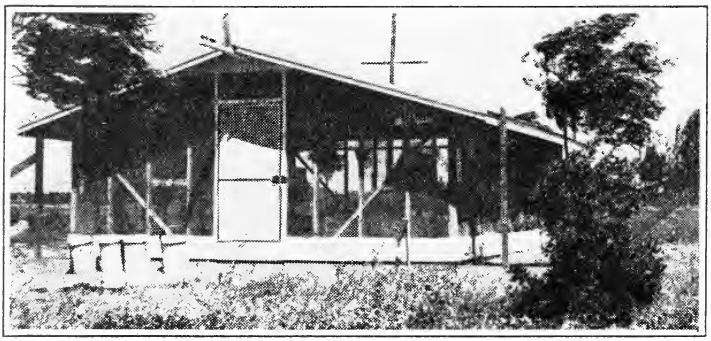


Fig. 2.—Wire-walled poultry house which may be used for brooding and for older birds where the climate is suitable.

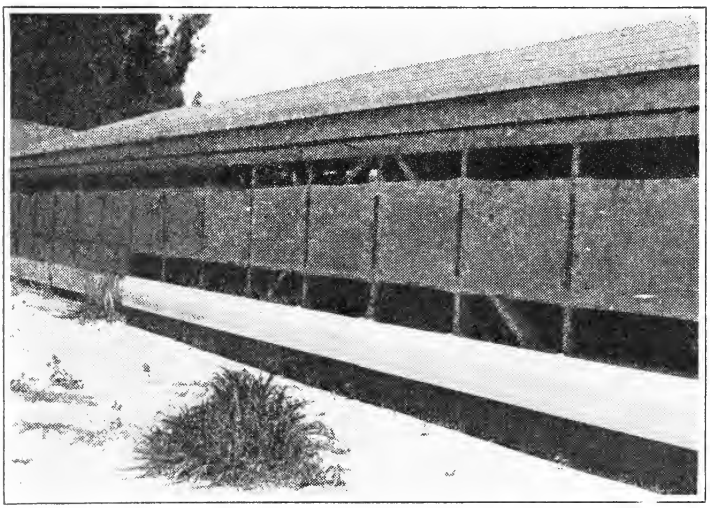


Fig. 3.—Muslin on the back of a wire-walled house to give added protection to the chicks.

of chicks are shown in table 2. The chicks require more floor space as they grow older. When straight-run chicks are brooded the additional space required can be provided, in part at least, by removing the cockerels. When pullet chicks are reared the pens will either have to be large enough to accommodate the birds for the length of time the birds are to be kept in them or the birds will have to be given more room to make sure that they are not crowded. Table 2 is based on the assumption that the number of pullets per pen will be adjusted at about 6 and 12 weeks of age.

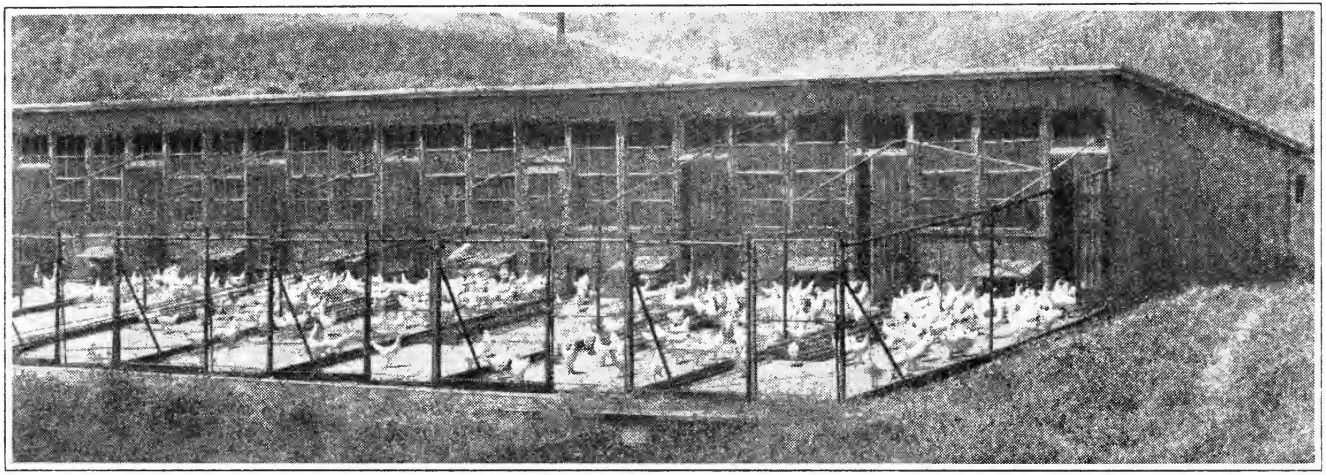


Fig. 4.—Brooder house, with concrete yards, suitable for use in all parts of the state.

Since yards cannot be used in wet, stormy weather, chicks brooded at seasons when such weather may be expected should be given the amount of house room recommended for chicks that do not have access to yards.

TABLE 1

RELATION BETWEEN FLOOR SPACE AND MORTALITY OF CHICKS*

Floor space per 100 chicks	Chicks	Deaths	Mortality to 3 months of age
sq. ft.	*number*	*number*	*per cent*
35 or less	73,077	19,257	26.3
35 to 50	25,371	4,122	16.2
50 or more	25,044	3,484	13.1

* From: Newlon, W. E., and M. W. Buster. Brooding and pullet management. California Agr. Ext. Cir. **28**: 14. Revised 1941. (Out of print.)

Good results are usually obtained with 300 to 500 chicks in each brooder. A smaller number are likely to require more labor per chick without enough advantage in rate of growth or uniformity of growth,

TABLE 2

RECOMMENDED SPACE PER CHICK FOR FLOOR-RAISED BIRDS

Chicks per brood	Amount of floor space to age in weeks given					
	With yards			Without yards		
	To 6 weeks	7–11 weeks	12–16 weeks	To 6 weeks	7–11 weeks	12–16 weeks
number	*sq. ft.*	*sq. ft.*	*sq. ft.*	*sq. ft.*	*sq. ft.*	*sq. ft.*
Under 100	50	75	120	60	90	150
250	125	185	285	150	225	360
350	175	260	400	210	315	500
500	250	375	575	300	450	710
750	375	560	835	450	675	1,060
1,000	500	750	1 110	600	900	1,410

while larger numbers in one brood may result in less uniform growth and increased mortality from crowding.

Yards.—Yards provide space for the birds to move around in without the expense of building walls and roofs. They also permit the birds access to direct sunlight. Since good results can be obtained without the use of yards, some poultrymen do not use them. Most poultrymen, however, use yards. The size of yard tends to vary with the price of land and the type of yard used. Dirt yards are usually larger than paved yards and wire or slat porches. If plenty of comparatively cheap land is available and the chicks are brooded in colony houses, free range may be used. This may help to reduce losses from some diseases if the houses are moved from

time to time. The birds range constantly over the ground near the house, but use land at a distance of 50 to 100 feet comparatively little unless feed and water are provided in the shade at this or a greater distance from the house.

When the house is left in the same place, the ground around it becomes fouled with manure. The manure can be swept up, which avoids any serious danger if only one brood a year is raised in the house. If two or more broods of chicks are started in the same house and on the same ground there is danger of contamination and of consequent heavy mortality among the later broods from ground-borne parasites. If dirt yards are used more than once during the season, the top 2 or 3 inches of soil should be removed and replaced with sand or clean soil before another brood is started.

Dry range contributes little to the nutrition of the chick or the growing bird. Birds ranged on alfalfa or clover will get considerable food from the range, which will reduce the amount of grain and mash consumed per pound of gain. Since such range must be irrigated in most parts of California, it is advisable to avoid soil contamination by starting only one brood on any particular part of the range in any one year, and by using the range only every other year.

For permanently located, large brooder houses, restricted yards are usually provided. If only one brood is started in any one year, dirt yards on both sides, with each yard used in alternate years, are satisfactory. If more than one brood is started during the year, the yards should be hard-surfaced or, alternatively, wire or slat yards may be built. Such yards require less land and, if properly constructed and managed, aid materially in controlling intestinal parasites. Furthermore, the space provided by the yards helps materially to lessen the danger of feather picking and cannibalism. Such yards are usually made 10 to 20 feet deep.

Concrete and other types of paved yards should slope away from the house at least 1 inch in 10 feet to ensure drainage and to aid in cleaning. The pavement should be cleaned regularly and kept reasonably dry; otherwise it will be no better than a dirt yard.

Wire[5] porches are widely used. Their use is particularly desirable where intestinal parasites are a serious problem. They can be made by stretching ¾-inch square mesh (16-gauge wire) hardware cloth on frames 3 feet by 6 feet; the frames are made of 1 by 6 inch lumber, on edge. Enough frames are placed side by side to provide the yard space required, usually the length of the house or pen and extending out from

[5] Some of the materials mentioned in this circular may become scarce or unavailable for civilian use because of the war. If the reader finds that some of these are unavailable he will naturally do the best he can with substitute or second-hand materials.

it to a distance of 6 to 12 feet. The chicks can walk on such wire reasonably comfortably and the wire is practically self-cleaning. The sanitary value of wire is nullified if the attendant carries infection onto the wire by walking on it. Droppings should be removed frequently enough from under the wire to control the fly menace, since flies are intermediate hosts for tapeworms.

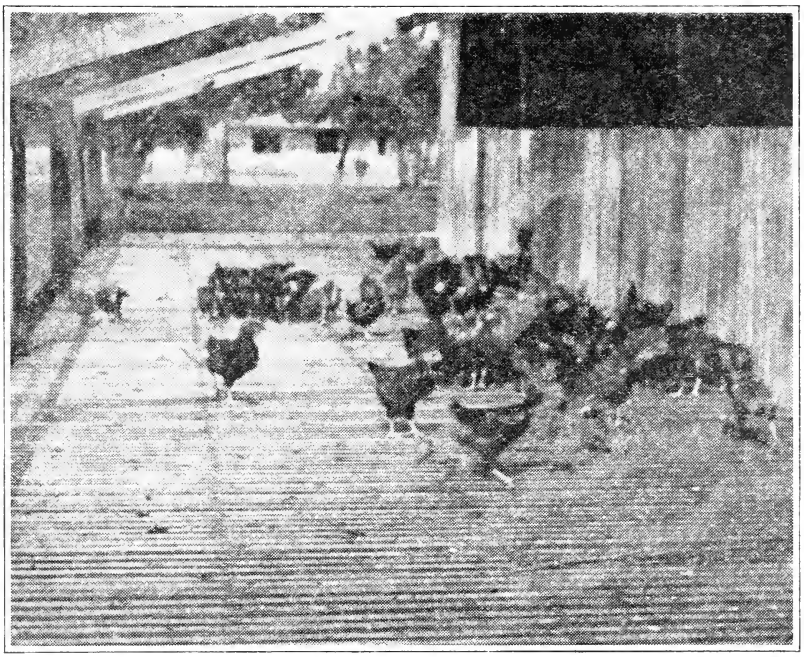


Fig. 5.—Slat yards may be used to control soil-borne intestinal parasites.

Slat porches are sometimes used, but they catch and hold more droppings and are therefore less sanitary than wire (fig. 5). Wire and slat porches are especially suitable for use on sloping ground. For a more complete discussion of yards and their management, see the section on "Rearing Pullets."

Shade.—Unshaded yards are used very little by the birds through most of the day in hot weather; hence, it is desirable to provide natural or artificial shade (see fig. 6). Natural shade is best provided by deciduous trees planted a sufficient distance from the house to prevent the trees from interfering with the entrance of light in the house during the winter months. Where irrigation is required, the trees should be outside the fences so that the yards may be kept as dry as possible.

Electric Brooders.—The electric brooder is the most convenient of the various fuel types of brooders used for floor brooding. Electricity is con-

venient because the temperature under the canopy can be maintained within narrow limits in most types; the room is not heated or only slightly—a desirable feature during most of the year; and the cost is usually about the same as for other economical fuels. The chief disadvantage is that severe storms may interrupt service and cause heavy losses among very young chicks unless they can be kept warm until power is restored. This is a problem that should be considered by those who brood chicks in the winter months or throughout the year. Some have met it by having auxiliary brooding equipment. Electric brooders should

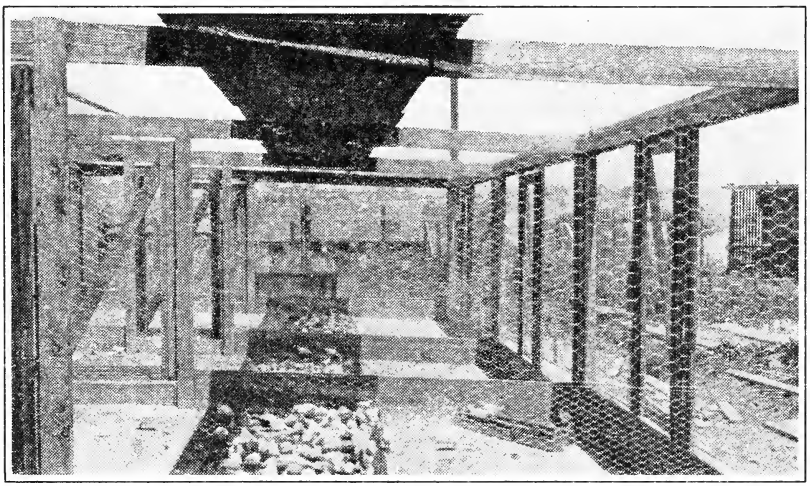


Fig. 6.—Concrete yard with artificial shade. Chicks need shade in hot weather. Feed and water should be in shade, too.

not be used where there are frequent interruptions in power supply. Auxiliary heat is desirable in areas having a very cold climate, but this is not a problem in most parts of California.

Electric brooders are made in a variety of types. The most widely used is a conical, galvanized-iron hover insulated against heat loss on the inside and having a width approximately twice its height (fig. 7). The brooder may be heated by nonglowing (black heat) or glowing (radiant) heating elements. The latter include a variety of types. According to work done at the Pennsylvania Agricultural Experiment Station,[6] pullets brooded under black-heat electric brooders were 10 to 20 days older when they started laying than pullets brooded under other types (coal, hot water, battery). There was, however, no effect on rate of growth as measured by body weight at different ages.

Hovers may or may not be equipped with curtains. Curtains tend to

[6] Callenbach, E. W., and J. E. Nicholas. Effect of rearing environment on sexual development of fowls. Pennsylvania Agr. Exp. Sta. Bul. 368:1–9. 1938.

retard air movement. Their use may cause poor ventilation and dampness under the hover unless fans are used. On the other hand, the fuel consumption of electric hover brooders with curtains is approximately half that of such brooders without curtains.

Electric-heating elements have been used in a wide variety of other types of brooders, including flat, wooden, homemade hovers. These function much the same as the conical type of hover by furnishing a heated

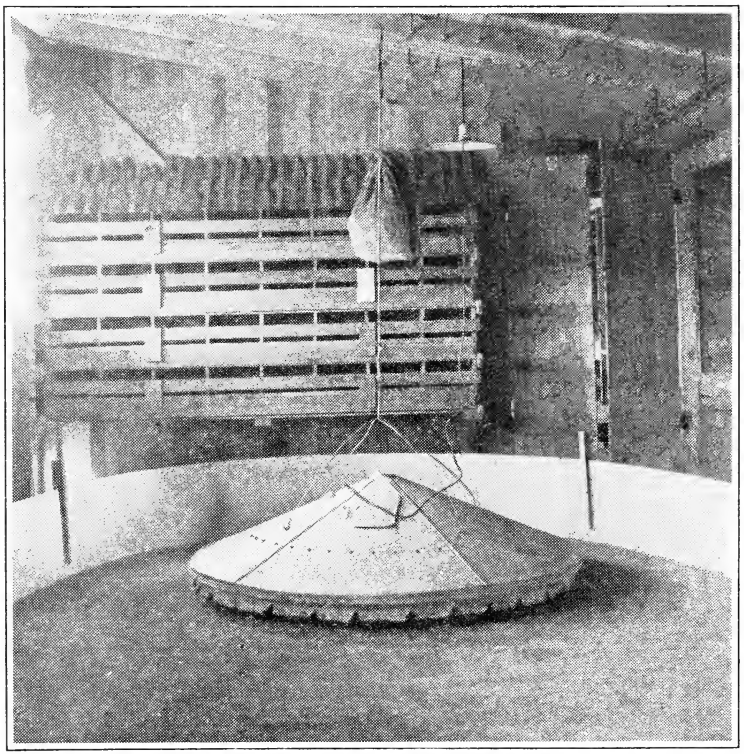


Fig. 7.—An electric brooder.

space for the chick. Contact brooders are also available. One type has a felt, composition, or rubber sheet heated from above, which is adjusted to come in contact with the backs of the chicks. It is claimed that the feathers on chicks brooded in contact brooders are smoother than those on chicks brooded in noncontact brooders. Contact brooders have the disadvantage that their height must be carefully adjusted to the size or height of the chicks. Another type of contact brooder is the feather brooder, with a small- or medium-sized globe so placed in the center of the hover that it will not touch or set fire to the feathers. Feather brooders are difficult to clean and the temperature cannot be maintained at any desired level.

Electric soil cables buried in sand are used to a limited extent for brooding, mostly during warmer weather. A wooden platform hover is placed over the heated area. Underground heat keeps the sand and litter dry and dries the droppings. Thermostats may be used with soil-cable brooders, but temperature control will be less precise than with most other types of electric brooders. Cables have also been used in concrete blocks, but there is little to recommend this permanently fixed type of installation.

Gas Brooders.—Gas lends itself well to brooding. Temperature control is much better than with most types of fuel other than electricity. Gas is economical and, compressed in tanks, can be used where piped gas is not available. Interruption of fuel supply is rarely a problem. Gas brooder stoves are capable of producing adequate heat under varying conditions (fig. 8).

Gas-, oil-, coal-, and wood-burning brooders all heat the room. Consequently, the size or heat-producing capacity of the brooder should be in proportion to the size of the room. A small gas or other brooder may be placed in a large room provided not too many chicks are put under it. An excessively large brooder should not be put in a small room, regardless of the number of chicks put under it, since it may overheat the entire room and may thereby cause heavy losses among the chicks.

Oil Stoves.—A variety of oil-burning brooders adapted to the various grades of fuel oil are available. They provide reasonably good temperature control and adequate heat under a wide range of climatic conditions. There is little danger of disrupted service when these brooders are properly installed and carefully operated, since the cause of interruption in service is most commonly a stopped feed line or failure of the operator to fill the fuel tank. Oil-burning brooders must be kept clean and properly adjusted, which requires more work than in the case of electric or gas brooders. There is also a greater fire hazard, but sand litter tends to lessen this risk.

Coal Stoves.—Suitable coal has not been available at favorable prices in most parts of California during recent years. Moreover, while coal brooders produce adequate heat, the temperature cannot be readily controlled to meet varying climatic conditions. Coal stoves require more labor to fuel, adjust, and clean. For the reasons mentioned, coal stoves are little used for brooding chicks in California.

Hot Water and Hot Air.—Most hot-water-pipe and hot-air-pipe brooders are expensive to install but relatively inexpensive to operate if used at their full capacity. Buildings used for such installations cannot conveniently be used for other purposes than brooding. The better installations provide heat and reasonably good heat control. Some of the poorer instal-

lations, particularly hot-air-pipe systems fueled with wood, are unreliable and give satisfactory results only at the cost of much extra labor.

Fireless Brooders.—Brooders made of feathers or felt, which keep the chicks warm by contact, are economical and will brood small lots of chicks satisfactorily if carefully operated. They should not be used except to brood lots of 100 chicks or less.

Fig. 8.—Gas brooder in use outdoors during the summer.

Other Brooder-Room Equipment.—Suitable feeders, waterers, and roosts should be provided. A tray 4 feet long, 5 inches wide, and 1½ inches deep—inside measurements—will provide adequate feeding space for 100 chicks. Trays of this type should have a grid made of ¾-inch-mesh hardware cloth, reinforced with a narrow edge of galvanized iron, to prevent wastage of the mash (see fig. 9). If narrow feeders are used, it may be necessary to provide hoppers 5 to 6 feet in length for each 100 chicks. Reel-type hoppers of suitable size similar to figure 12 are more sanitary than trays and should be used after the chicks learn to eat.

A 1-gallon fountain is recommended for every 75 to 100 chicks. Various types of automatic waterers can be used, particularly after the first few days. The waterers should be on wire or other platforms after the first few days to lessen trouble with wet litter. Platforms also tend to keep litter out of the water.

Guard fences should be placed around the brooder the first few days. These are made of various materials such as: roofing paper cut into strips 1 foot wide; chicken netting 1 foot wide and covered with muslin or burlap; or boards. The fences are usually placed 18 inches or more out from the edge of the canopy. With curtained electric brooders it is advisable to have the guard fence touch the canopy at one edge of the hover. The space enclosed by the fence should be increased after the first day or two and the guard eliminated completely after the first few days when the chicks are trained to go to the hover for heat. (See fig. 1, p. 8.)

Roosts are usually provided after the chicks reach 4 or 5 weeks of age. These can be made of 1 by 2 inch pieces of lumber laid flat and with the

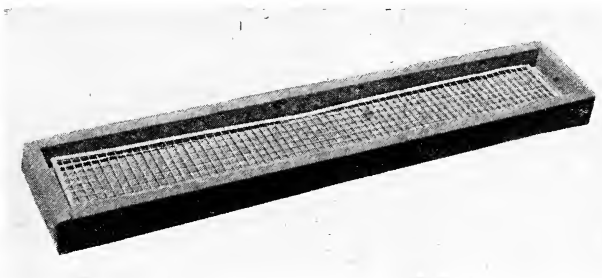


Fig. 9.—Baby-chick mash hopper. A hopper 4 feet long, 5 inches wide, and 1½ inches deep, inside dimensions, is a very convenient size. (From Bul. 476.)

edges smoothed. These are nailed to a frame at a height of about 12 inches above the floor. Roosts nailed to frames over 1-inch-mesh poultry netting with an approach similarly constructed may be used to teach the chicks to roost.

Brooder Management.—The brooder should be checked for defects and then operated for a day or two before chicks are put under it to make sure that it is in good working order. The brooder should be regulated to a temperature of about 90° to 100° F at a point about 2 inches above the floor near the outer edge of the canopy; for gas brooders the temperature should be taken 2 or 3 inches outside the edge of the canopy. The exact temperature will need to be varied according to the type of brooder, the position of the thermometer, and weather conditions. After the chicks are placed in the brooder they should be watched and the temperature changed to keep them comfortable. It is very important to maintain the temperature so that the chicks will spread evenly under or around the brooder.

Feed and water should be provided before the chicks are placed in the brooder. It is desirable to have the chicks eat up all the feed in the hoppers once a day. The trays should then be cleaned before they are refilled.

Care should be taken to see that the chicks are not left without feed for any length of time. For the first day or two, feed should be spread on egg flats, paper, or boards, in addition to the regular trays, to ensure that the chicks learn to eat.

The waterers should be cleaned and refilled at least once daily. Litter should be placed on the floor to facilitate cleaning. The litter used may be sand, rice, cottonseed[7] or other hulls, cut straw, peat moss, processed sugar-cane stalks, or wood shavings. A thin coat of litter is preferable to deep litter, since anything added beyond a thin layer does no good and is wasted. Sand may be sprinkled on the floor under the other types of litter. Sand is particularly desirable around oil-burning brooders for protection against fire. Where sand is used a common practice is to cover the floor enclosed by the guard with burlap for the first 2 or 3 days. This is usually not necessary when feed is kept before the chicks, since there is little danger that the chicks will eat harmful amounts of sand or other litter unless they are starved.

In cold weather the chicks should be moved in chick boxes or other suitable covered boxes to guard against chilling and placed under the brooder. They may be put under the brooders at 24 hours of age, at which time they are ready for feed and water.

Chicks fed a well-balanced ration containing an adequate amount of vitamin D do not need to get outside. On the other hand, chicks that are outside in the sunlight daily do not need vitamin D in their ration. There is usually less trouble with cannibalism and other vices, however, if the chicks have access to an outside yard or porch after the first few days. Therefore, allowing floor-brooded chicks access to clean, outside yards in favorable weather promotes health and simplifies management.

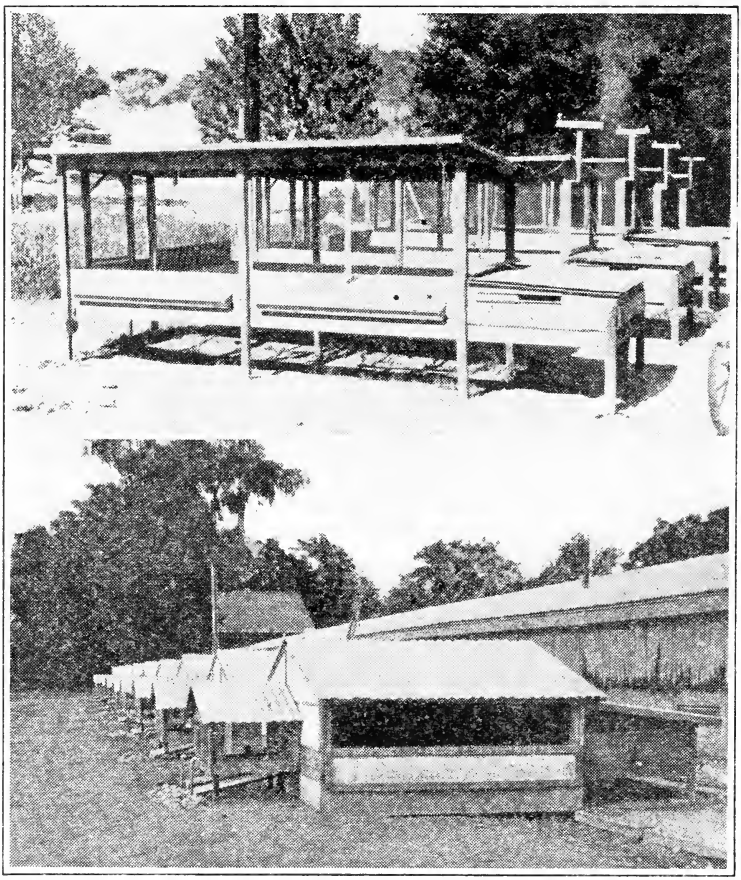
The chicks may be encouraged to roost after they are 4 or 5 weeks old. If roosted too early on narrow roosts many will develop crooked keels. Leghorn chicks take to roosts much more readily than chicks of the heavier breeds, but the latter will usually learn in 2 or 3 days if placed on, or driven onto, the roosts at dusk. If chicks crowd into corners on the floor some of them may be smothered. Others may be partly asphyxiated and fail to grow properly. Such birds frequently develop into runts and worthless culls.

OUTDOOR BROODING

Outdoor brooders are widely used in the southern part of the state and, to a limited extent, in other parts of California. No brooder house is used and no protection is afforded the attendant. The system is, there-

[7] Cottonseed hulls should not be used as litter in houses for laying hens because of their effect on egg quality. The eggs from such hens, if placed in cold storage, may develop discolored yolks.

fore, unsuitable for use in some of the wetter and colder parts of the state. The chief advantage of this system is the comparatively low initial investment without increase in labor cost. Another advantage is that the birds do not come in contact with contaminated soil and the attendant remains outside the runway.



A

B

Fig. 10.—*A*, A common type of outdoor brooder; *B*, an outdoor brooder with drinking cups in compartments at the left.

Brooders.—The brooders consist essentially of a heated, ventilated box with a wire runway or porch (see fig. 10, *A* and *B*). The box is usually well insulated to reduce fuel consumption. Proper insulation effects a worth-while saving in fuel consumption, which more than offsets the increased cost of construction. The use of a galvanized-iron sheet for the ceiling of the box, it is claimed, helps to spread the heat and distribute the chicks evenly at night.

The depth of the box is usually 12 inches or more, with 7 inches or

more above the ½-inch-mesh wire screen that the chicks walk on. Underneath this wire screen is placed a galvanized-iron droppings pan or a floor; or the droppings may be allowed to fall on the ground or onto a concrete slab. If not provided with a floor, the brooder box should be set near the ground and the space underneath enclosed in cold weather to conserve heat. Two sets of screens may be provided for each box, although this is not essential. If a larger mesh screen is to be used after the first week or two, provision may be made for placing it lower in the box, or it can replace the initially used smaller mesh screen when it is removed and thus leave the wire floor at the same level in the box.

The box may be ventilated by suitable openings or by means of the curtain-covered opening onto the wire run *plus* a fan. The opening provided to permit the chicks to go onto the wire porch should extend the entire width of the box and be about 10 inches high.

The wire run or porch should be at the same level as the floor screen of the box, but the roof or top screen may be twice the height of the brooder box to help prevent the chicks from flying out when the top is opened. The runs vary in length from 6 to 14 feet; 8 or 10 feet are the commonest lengths, with a 4 by 4 foot brooder box. Some operators prefer a narrower, 3-foot wide brooder and run to facilitate handling the chicks. When used for year-round brooding the run should also have a roof.

Feeders and Waterers.—Feeders and waterers may be placed in the brooder box if sufficient light is available, or on the wire run, according to the age of the chicks and weather conditions. They may also be placed on brackets at the sides and end of the wire run to facilitate filling and cleaning and to prevent the chicks from contaminating the feed and water.

Roosts need not be used in these brooders, but if desired, 2 by 3 inch or 4 inch roosts may be laid flat in the wire runs.

Management.—The chicks may be placed directly in the brooders and left there until they can do without heat. Many of the outdoor brooders in use are not suitable for holding the chicks more than 6 weeks. While 200 chicks can be started in a brooder with a 4 by 4 foot brooder box, it is not advisable to start more than 125 if the chicks are to be kept in the brooder to 5 or 6 weeks of age and not more than 100 if kept to 7 weeks of age. The temperatures in the brooder box and methods of feeding and watering are the same as with floor brooding.

The droppings should be removed from under the brooder box daily or at least every other day. The droppings under the wire run may, however, be left much longer if the droppings dry rapidly and therefore do not serve as a breeding place for flies.

The brooder should be thoroughly cleaned and disinfected at the end of each brood before chicks are again started. A soaking platform is useful for cleaning the screens.

BATTERY BROODING

Battery brooders are used by hatcheries to hold surplus chicks until they can be sold, and by fryer producers to brood their chicks (fig. 11). They are little used by egg producers because of the large investment in brooding equipment for each chick brooded where only two or three broods are started each year.

Housing Requirements.—For year-round brooding the temperature, ventilation, and humidity of the battery brooder room should be controlled. In large rooms plenty of air space and positive, fan-controlled ventilation are necessary.

The battery room should have a concrete floor with a slope of at least 1 inch in 10 feet to permit water to flow freely into a drain. The walls and ceiling should be well insulated. The ceiling should be not less than 2 feet above the top of the battery, preferably more. Windows, if used, are best placed fairly high in the wall and so spaced that they furnish an even distribution of light. When windows are used to ventilate the room they should open at the top and be constructed to prevent direct drafts.

Fans to control ventilation can be placed either in the ceiling or the walls. The fans should not blow air directly on the chicks. One 19-inch, 1,750-r.p.m. fan driven with ¼ hp. motor or two smaller fans will ordinarily be adequate for a room about 40 by 20 feet. During hot weather the air brought into the room by the fans may be drawn through wet excelsior pads to maintain the relative humidity at not less than 65 per cent and to hold the room temperature down to 80° F or less. Outlets should be so placed that they will aid the fans to insure adequate distribution of the air. A heater may be needed in cold weather to maintain the temperature of the room at 60° to 80° F.

The size of the room will depend on the number of chicks to be brooded and the number and size of the batteries to be used. Since batteries vary in size and shape, it is advisable to select the batteries before the room is built. It is also advisable to allow at least 15 inches between batteries and to have the aisles at least 3 feet wide. The relation between the number and age of the chicks and the floor space required is shown in table 3.

Battery Brooders.—Battery brooders are usually three to six tiers high; the height depends to some extent on the height of each tier. The amount of headroom needed for the chicks will, in turn, depend on how

long they are to remain in the battery. A lower ceiling for each compartment is adequate if the chicks are to be kept in the battery for not more than 2 weeks; if they are to be kept in the battery for more than 4 weeks,

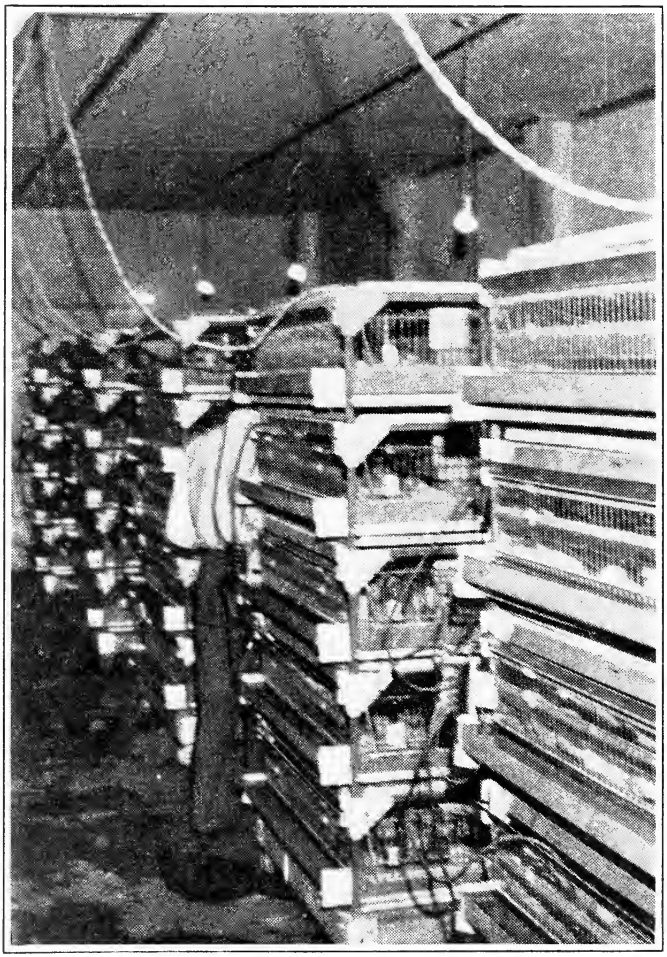


Fig. 11.—Electric batteries used for brooding chicks.

or until they can do without heat, a higher ceiling is necessary. Two types of batteries may also be used and the chicks moved at 2 or 3 weeks of age.

Batteries are generally heated with electricity, but gas and oil are also used. There is much variation in the construction of batteries. A separate heated compartment is provided at one end in some batteries, while in others the heated compartment is in the center. Contact heat batteries are also available.

When purchasing a battery, ease of operation and accessibility of all parts should be taken into consideration. The floor grids, feed and water troughs, as well as the droppings pan, should be easily removed for cleaning. It is desirable to have the battery mounted on casters with the lowest tier 15 to 18 inches above the floor. The battery should be sturdily built of galvanized iron or other nonrusting metal.

Management of Battery Brooders.—The temperature in the heated compartment of the battery is approximately the same as under other brooders—namely, about 95° F at first, gradually reduced to 85° or 80°

TABLE 3

SPACE AND AIR REQUIREMENTS OF CHICKS IN BATTERY ROOMS AND BATTERIES

Age of chicks	Estimates—battery floor*		Estimated number of cubic feet of air required each minute by 100 birds‡
	Floor space per 100 chicks†	Chicks per 100 square feet of floor space†	
weeks	*sq. ft.*	*number*	*cu. ft.*
1	6.25	1,600	1.6
2–3	12.50	800	2.0
4–5	17.36	576	2.5
6–7	25.00	400	3.0
8–9	31.25	320	3.5
10–11	41.67	240	4.0
12	52.08	192	—§

* The battery *room* floor space required is approximately the same as the *battery* floor space requirements given for installations of several batteries. The floor space required will, of course, vary with the number of tiers in the battery.

† Based on data given by: Lee, C. E. Profitable chick battery and laying cage management. 4th ed. 82 p. The Beacon Milling Company, Inc., Cayuga, N. Y. 1939.

‡ This is the minimum below which condensations of moisture would occur. The air requirements given in this column were calculated by Professor R. L. Perry (University of California, Division of Agricultural Engineering, Davis) and were based on air entering with a 60° dew point absorbing 0.007 pound of vapor per pound of air.

§ Dash indicates data not available.

F at the time heat is discontinued. A room temperature of 60° F gives good results with contact-type brooders.[8] Most operators, however, prefer a room temperature of 70° or even 80° F.

The relative humidity of the room is regulated to keep it at not less than 65 per cent. This is done by means of a wet excelsior pad through which the air is drawn by a fan during warm weather, by means of a humidifier on the heater during cool weather, by sprinkling water on the floor or by a combination of these methods.

The available information regarding requirements for brooder-room space and air supply is summarized in table 3. At the minimum air rates given therein, the number of air changes per hour will be from 0.7 to 1.7. More ventilation than this is likely to be required for the comfort of

[8] Lee, C. E. Profitable chick battery and laying cage management. 4th ed. 82 p. The Beacon Milling Company, Inc., Cayuga, N. Y. 1939.

the attendant. Up to 8 changes of air per hour will be found adequate for a room loaded to its full capacity with chicks. This can be supplied without objectionable drafts by a properly designed duct system.

Daily removal of droppings is recommended. The battery should be thoroughly cleaned after each brood and the floor grids, feeders, waterers, and dropping pans washed and disinfected before more chicks are started. It is desirable to have the battery rooms of such a size and number and the brooding schedule so arranged that the room can be depopulated and disinfected after each brood of chicks. In case of an outbreak of disease, depopulation, thorough cleaning, and disinfection are recommended before starting another brood.

RENEWING THE FLOCK

The flock can be renewed by the purchase of hatching eggs, the purchase of day-old chicks, or of partly raised pullets. Commercial poultrymen can best renew their flocks by the purchase of day-old chicks—the most commonly used method—because it has been found to be the most economical and least hazardous of the methods available to the poultryman. All the chicks required to renew the flock can be purchased at one time if that seems advisable. Two or three broods a year, however, will permit more efficient use of brooder equipment and labor, and ensure a more even distribution of egg production.

Started pullets may carry a variety of diseases onto the place. Day-old chicks, on the other hand, are relatively less likely to carry diseases other than those transmitted through hatching eggs or acquired in incubators, such as pullorum disease or paratyphoid. From the standpoint of disease control it is therefore safer to purchase chicks than started pullets. This is particularly important when starting a poultry flock on a new place or on one that has been vacant for some time.

Season for Brooding.—Most poultrymen get somewhat better results in growth and egg production from pullets hatched from December 15 to March 15 than at other times of the year. This favorable period may extend somewhat later in coastal and certain other areas of the state. The results obtained will vary from year to year according to weather conditions. For this reason, results obtained in one area should not be used to predict results in another area and in a different year. Nevertheless, some general trends emerge from studies of birds hatched in different seasons. Data from such studies in three states are summarized in table 4. It will be observed that the egg production of the June-hatched birds varied from next to the highest (New Jersey) to the lowest (New Mexico) of any group. The data for Oklahoma were obtained by averaging the average production of two or three groups hatched in each

particular month. The two groups of pullets hatched in one month (September) differed in average first-year production by as much as 36.7 eggs, which indicates that factors other than seasonal differences had an effect on the results. Nevertheless, there is a distinct tendency for the June-, September-, and November-hatched birds to lay fewer eggs than the January- to April-hatched birds, presumably because the former are more likely to go through a complete molt before finishing a full year of production.

TABLE 4

EFFECT OF DATE OF HATCH ON EGG PRODUCTION, FEED CONSUMPTION, MORTALITY, AND EGG CHARACTERISTICS

Date of hatch	Eggs per hen on a hen-day basis			Other data from New Jersey study*					
	New Mexico†	Oklahoma‡	New Jersey*	Percentage large eggs	Total feed consumed, 0–24 weeks	Mortality§ 0–24 weeks	Mortality§ 25–76 weeks	Percentage of eggs fertile	Percentage of eggs hatched
	number	*number*	*number*	*per cent*	*pounds*	*percent*	*percent*	*per cent*	*per cent*
January	124.3¶	155.9	148.4	47	20.2	20.0	45.4	75	59
April	155.7	146.4	173.3	55	18.8	12.3	30.5	76	66
June	110.7	128.0	165.5	42	18.7	10.8	35.7	78	58
September	128.3	112.9	142.9	38	21.9	8.4	48.6	57	48
November	136.0	126.4	146.2	43	22.5	16.4	40.0	66	46

* Jeffrey, F. P., and C. S. Platt. A 3-year study of out-of-season hatching. New Jersey Agr. Exp. Sta. Bul. **687**: 1–23. 1941.

† Berry, L. N., and A. L. Walker. The influence of the time of hatch on the laying ability of Single-Comb White Leghorn pullets. New Mexico Agr. Exp. Sta. Bul. **158**: 1–18. 1927.

‡ Upp, C. W., and R. B. Thompson. Influence of time of hatch on hatchability of the eggs, rate of growth of the chicks, and characteristics of the adult female. Oklahoma Agr. Exp. Sta. Bul. **167**: 1–36. 1927.

§ Complicated by mortality from pox, laryngotracheitis, chick bronchitis, and coccidiosis.

¶ Hatched in February.

The September-hatched birds laid relatively small eggs. The differences here are mainly due to temperature conditions. September- to November-hatched birds are usually smaller than January- to April-hatched birds when they start to lay. For this reason, summer- and fall-hatched birds tend to lay smaller eggs than spring-hatched birds. It should be remembered that high temperature also reduces egg size in mature birds.

There appear to be no differences in feed consumption that can be attributed to date of hatch. Chicks hatched and raised in warm weather (April to June) consumed less feed during the growing period. The differences in mortality shown in table 4 probably reflect the effects of local conditions rather than general trends. On the other hand, the lower fertility and hatchability of eggs incubated in September and November (not, it should be noted, the eggs laid by September- to November-hatched birds) is commonly observed (table 4).

Some of the disadvantages of out-of-season hatching may be overcome by careful management, including proper nutrition and the judicious use of lights. Pullets hatched outside the regular season may be used to replace birds that die or are culled and thus keep the houses more nearly filled to capacity throughout the year. The use of such pullets should help to distribute egg production more evenly throughout the year.

How Many Chicks to Brood.—The results of enterprise-efficiency studies[9] and other surveys indicate that best returns are usually obtained from flocks comprising about 60 or 65 per cent pullets, the remainder of the flock being made up of hens in their second or later laying years. Many factors influence replacements; therefore, the number needed may be much lower on some farms than on others. In recent years, the actual percentage replacement has increased on farms surveyed from less than 50 to over 80 per cent owing to an increase in mortality (range in annual average died, 15 to 33 per cent) and an even greater increase in the percentage culled (range in annual average culled, 29 to 69 per cent). The average of 16 yearly averages (1925 to 1940) was 24.6 per cent mortality and 47.3 per cent culled, or a replacement of 71.9 per cent.

The mortality from time of hatch to laying age varies and thus affects the percentage of pullets that are available for the laying flock. The average brooder mortality is low, but the number lost between the brooder house and the laying house is fairly high. Thus, records show that the number of pullets housed ranges all the way from 25 to more than 45 per cent of straight-run chicks started, or 50 to 95 per cent of the pullet chicks started. Thirty-five (70 per cent of the pullets) out of every 100 straight-run chicks started is not far from the average number of pullets housed. The number of chicks required to replace different percentages of the laying flock is shown in table 5. It is assumed that equal numbers of males and females are found in straight-run chicks. Cockerel mortality does not affect the figures in table 5.

Sources of Stock.—Chicks may be obtained from various sources such as: a breeder who is doing trap-nesting, pedigree breeding, and progeny testing, and who selects for livability, egg production, egg size, and body weight; a hatchery that sets only large eggs (23 ounces or over per dozen) obtained from carefully selected, well-matured hens mated to males out of high-producing hens with known individual and family records; one's own breeding flock, provided care is taken to use only eggs selected for size, shape, and shell texture laid by hens selected for size, apparent vigor, and egg production by eliminating the slow-maturing

[9] Shultis, A. Summary—poultry management study records by years. 1 p. California Agr. Ext. Serv. 1941. (Mimeo.)

birds and those that winter pause, go broody, or molt early. For further information about breeding for egg production, consult Bulletin 626.[10]

Definite evidence should be secured that all flocks from which hatching eggs or chicks are obtained have been systematically tested for pullorum disease until none or a very small percentage of the breeding birds give

TABLE 5

NUMBER OF CHICKS REQUIRED PER 1,000 LAYING HENS TO REPLACE VARYING PERCENTAGES OF THE LAYING FLOCK AT DIFFERENT LEVELS OF BROODER PLUS REARING MORTALITY

Brooder plus rearing pullet mortality	Percentage of laying flock to be replaced										
	40	45	50	55	60	65	70	75	80	85	90
Straight-run chicks											
per cent	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*
5	842	947	1,053	1,158	1,263	1,368	1,474	1,579	1,684	1,789	1,895
10	889	1,000	1,111	1,222	1,333	1,444	1,556	1,667	1,778	1,889	2,000
15	941	1,059	1,176	1,294	1,412	1,529	1,647	1,765	1,882	2,000	2,118
20	1,000	1,125	1,250	1,375	1,500	1,625	1,750	1,875	2,000	2,125	2,250
25	1,067	1,200	1,333	1,467	1,600	1,733	1,867	2,000	2,133	2,267	2,400
30	1,143	1,286	1,429	1,571	1,714	1,857	2,000	2,143	2,286	2,429	2,571
35	1,231	1,385	1,538	1,692	1,846	2,000	2,154	2,308	2,462	2,615	2,769
40	1,333	1,500	1,667	1,833	2,000	2,167	2,333	2,500	2,667	2,833	3,000
Pullet chicks											
per cent	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*
5	421	474	526	579	632	684	737	789	842	895	947
10	444	500	556	611	667	722	778	833	889	944	1,000
15	471	529	588	647	706	765	824	882	941	1,000	1,059
20	500	563	625	688	750	813	875	938	1,000	1,063	1,125
25	533	600	667	733	800	867	933	1,000	1,067	1,133	1,200
30	571	643	714	786	857	929	1,000	1,071	1,143	1,214	1,286
35	615	692	769	846	923	1,000	1,077	1,154	1,231	1,308	1,385
40	667	750	833	917	1,000	1,083	1,167	1,250	1,333	1,417	1,500

a positive reaction. It is advisable to obtain a statement showing when the last test was made and the number of reactors that were found and whether all reactors were removed.[11]

Because of the variations in quality, too much attention cannot be given to selecting a good source of stock. In general, it is desirable to buy the best chicks available. If chicks from good stock are not available locally, then they should be obtained from the best source available elsewhere. It is desirable to visit the breeder or hatchery from which chicks

[10] Taylor, Lewis W., and I. Michael Lerner. Breeding for egg production. California Agr. Exp. Sta. Bul. 626:1–48. Revised 1942.

[11] For further information concerning pullorum disease, the reader is referred to: Beach, J. R., and M. A. Stewart. Diseases of chickens. California Agr. Exp. Sta. Bul. 674:26–39. 1942.

are to be obtained in order to verify as far as possible all claims made. At any rate, there is little excuse for the practice of buying chicks from remote sources that subject chicks to the hazard of several days en route and effectively prevent the buyer from obtaining any reliable information about the quality of the breeding stock.

In case of doubt about the quality of the stock, the practice of trying two or more strains is desirable. The chicks from each strain should be brooded separately, the pullets housed separately, and careful records kept of the amount and causes of *all* mortality, egg production, egg size, and other matters that would aid in deciding which strain is most profitable to use.

Straight-Run vs. Sexed Chicks.—Pullet chicks can be distinguished from cockerels by cloacal examination on removal from the incubator.

It is now a common practice to purchase pullets rather than straight-run chicks and thereby reduce the number of chicks brooded.

The cost of the mature pullet is, on the average, greater when pullet chicks rather than straight-run chicks are purchased. The purchaser usually pays for both the cockerels and pullets, plus the cost of sexing (segregating the chicks according to sex) but may arrange to receive only the pullets. Since the cockerels, when raised to broiler size, usually return the cost of brooding (feed, labor, fuel, litter, depreciation on equipment, and other minor items) and, except late in the spring, part or all of the purchase price with, in some cases, a profit besides, failure to take the cockerels naturally increases the cost of the pullets. This increased cost may be justified where the pullets receive added room and care and, accordingly, grow faster, more evenly, and suffer less mortality.

Cloacal examination and segregation of the chicks according to sex by properly qualified persons has no effect on subsequent growth of the chicks or the performance of the pullets.

FEEDING

The food requirements of chicks are now sufficiently well known so that it is possible to formulate rations which supply adequate amounts of proteins, vitamins, minerals, carbohydrates, and fats in proper proportion. This does not imply that all the nutritional requirements are known, but merely that sufficient information is available for most practical needs.

When to Feed.—Chicks can be fed when they are sufficiently dried off so that they are fluffed out and active. This means that they are ready to feed when 24 to 36 hours old. Chicks suffer little harm when left without food up to 60 hours, although they lose about 1 pound per 100

chicks the first 24 hours and slightly less each 24 hours thereafter that they are left without food. Chicks can usually go without food for another 12 to 24 hours (that is up to 72 to 84 hours), but if left longer than 90 hours without food mortality among chicks will usually be increased. These time intervals indicate the dangers of delayed feeding. When chicks are purchased they should have access to feed and water on arrival.

TABLE 6

CHICK-MASH FORMULAS* †

Ingredients	Chick mash 1		Chick mash 2		Chick mash 3	
	Percentage	Amount per ton	Percentage	Amount per ton	Percentage	Amount per ton
	per cent	*pounds*	*per cent*	*pounds*	*per cent*	*pounds*
Constant ingredients:						
Fish meal (65 per cent crude protein)	12.5	250	7.5	150	15.0	300
Dried skim milk, dried buttermilk, or dried whey	5.0	100	5.0	100	2.0	40
Alfalfa meal	7.5	150	7.5	150	10.0	200
Meat scrap (55 per cent crude protein)	....	...	6.0	120	....	...
Bone meal	1.0	20	....	...	....	...
Ground limestone or oystershell	2.0	40	2.0	40	2.5	50
Salt	0.5	10	0.5	10	0.5	10
Cane molasses	....	...	....	...	3.0	60
Fish oil, 100-D‡	0.5	10	0.5	10	0.5	10
Variable ingredients:						
Wheat bran	16.0	320	16.0	320	20.0	400
Ground yellow corn	25.0	500	25.0	500	20.0	400
Ground wheat	15.0	300	15.0	300	10.0	200
Ground barley	15.0	300	15.0	300	16.5	330
Total	100.0	2,000	100.0	2,000	100.0	2,000

* From: Almquist, H. J., T. H. Jukes, and W. E. Newlon. Feeding chickens. California Agr. Ext. Cir. **108**: 35. Revised 1940.

† If used for battery broiler production, these mashes should be supplemented with 4 ounces of manganese sulfate, or 3 ounces of manganese carbonate per ton of mash. The manganese should be premixed in the ground limestone or oystershell flour.

‡ Or 400-D oil, 0.125 per cent (2.5 pounds per ton).

What to Feed.—Chicks are usually started on an all-mash ration. Grain feeding may begin at any time, the exact age and the proportion of grain depending on the protein level of the mash and the rate of growth desired.

Clean water should always be available. Limestone grit or oystershell should not be fed separately to chicks that have access to a properly formulated commercial or other mash, since such mashes contain adequate amounts of calcium for growth. Additional calcium may, therefore, be injurious. Hard (granite) grit should be fed.

Fresh, tender greens may be fed at any time, but usually are omitted the first few weeks and need not be fed with properly formulated rations. After the first few weeks it is desirable to feed fresh greens in amounts corresponding to about 10 to 25 per cent of the mash and grain fed.

Formulas for starting mashes are presented in tables 6 and 7. These mashes may also be fed to developing pullets.

TABLE 7

ADDITIONAL CHICK-MASH FORMULAS* †

Ingredients	Chick mash 4 (20–21 per cent crude protein)		Chick mash 5 (18–19 per cent crude protein)	
	Percentage	Amount per ton	Percentage	Amount per ton
	per cent	*pounds*	*per cent*	*pounds*
Constant ingredients:				
Fish meal (65 per cent crude protein)	5.0	100	4.0	80
Meat scrap (50 per cent crude protein)	5.0	100	2.0	40
Dried skim milk, dried buttermilk, or dried whey	5.0	100	5.0	100
Alfalfa meal	7.5	150	7.5	150
Soybean meal (44 per cent crude protein)	15.0	300	12.5	250
Bone meal	1.0	20	1.0	20
Ground limestone or oystershell	1.5	30	1.5	30
Salt iodized	0.5	10	0.5	10
Vitamin-D carrier, 100-D‡	0.5	10	0.5	10
Variable ingredients:				
Wheat bran or mill run	15.0	300	15.0	300
Ground corn, milo, or kafir	10.0	200	15.5	310
Ground wheat	15.0	300	10.0	200
Ground barley	19.0	380	25.0	500
Total	100.0	2,000	100.0	2,000

* From: Almquist, H. J., T. H. Jukes, and W. E. Newlon. Supplement to California Agricultural Extension Service Circular 108. 2 p. 1942.

† If used for battery broiler production, these mashes should be supplemented with 4 ounces of manganese sulfate or 3 ounces of precipitated manganese carbonate per ton of mash, premixed in the ground limestone or oystershell.

‡ Or proportionally lower amounts of poultry vitamin-D carriers of higher guaranteed potency.

How to Feed.—For the first day or two in the brooder until the chicks have learned to eat, it is advisable to scatter mash on egg-case flats, boards, building paper or other paper. The mash is also placed immediately in the feed hoppers, which are used exclusively once the chicks have learned to eat. Later, when grain is fed, it should likewise be hopper-fed.

It is advisable to feed only the amount cleaned up in a day. The chicks should not, however, be left without feed for any appreciable length of time.

BROODER VICES

Cannibalism.—Cannibalism in one form or another is fairly common among young chicks, growing pullets, and laying birds. In young chicks, toe picking is the commonest form of cannibalism encountered,

but picking of other parts may also follow if the toe picking is not checked. In slightly older birds feather picking is common. A limited amount of apparently harmless feather picking sometimes occurs, but it may develop to the point where the birds are completely naked and may lead to cannibalism.

Some outbreaks of cannibalism are perhaps to be regarded as purely accidental. Chicks pick at each other's toes and, if blood is drawn, the picking may develop into a vice unless it is promptly checked. Such accidental cases are not likely to cause serious difficulties if the birds receive regular and reasonably frequent attention.

Other outbreaks of cannibalism are caused by overcrowding, hunger, usually a result of irregular care, chilling, overheating, or general discomfort, and inactivity. Regular care of the birds and keen observation will do much to prevent outbreaks of cannibalism.

Picked birds should be promptly removed and the offenders also removed if possible. Young chicks that have been picked should have pine tar or other adhesive anti-pick ointments applied to the affected parts. It is usually advisable to isolate them for a few days. The cause should be looked for and, if found, corrected.

To check the vice, common salt may be added to the mash. The salt content of the ration should be increased to 2 or 3 per cent for a few days *only*. Mash usually contains about 1 per cent of salt; hence, 1 or 2 per cent should be added. If this is not effective, the salt may be increased to 4 per cent. When grain and mash are fed, the amount of salt added should be correspondingly increased. For instance, if the birds are eating equal parts of mash and grain and the mash contains 1 pound of salt in each 100, then an additional 3 pounds of salt should be added to each 100 pounds of mash. The high salt mash should not be fed for more than a few days.

Crowding.—Crowding or piling into corners of the brooder house is another dangerous vice. This is not solely a matter of the land or house space, but involves also the distribution of the feeders and the waterers and their accessibility.

Chilling is the most prevalent cause of crowding, but an overheated brooder often forces chicks to seek comfort in the far corners. Bright moonlight shining through low windows may draw the chicks toward the light. Rats or mice may stampede the chicks into a corner, or a wagging flashlight in the hands of a careless attendant may frighten the chicks and cause crowding or piling. This is particularly true if they are disturbed soon after dusk.

The remedy consists of eliminating the cause first. An hour or so after dark, the chicks should be gently herded back into position around

the brooder stove. With the aid of a dim light and a broom the chicks may be spread out very easily. A dim light under the hover tends to eliminate crowding into the corners, and dim lights over the roosts seem to aid in teaching the chicks to roost early.

Sections of sloping roosts placed in the corners will minimize danger from crowding and teach the chicks to roost. Inch-mesh chick wire tacked to the bottom side of the roosts will keep chicks off the floor in the corners.

DISEASES AND PARASITES OF CHICKS[12]

The present practice of maintaining large numbers of birds in small areas, and of concentrating poultry farms in certain districts without a proportionate concentration of effort to control transmissible diseases and parasites are important reasons for much poultry mortality in California. In fact, unpublished summaries from California enterprise-efficiency records show that mortality on poultry farms tends to be directly proportionate to the size of the flock.

Efforts to control poultry mortality by curative treatment is in most instances impractical. Successful treatment of sick birds requires individual care, often several times a day, and also may require considerable skill. Preventive measures are, therefore, the most practical means of controlling the poultry-disease problem.

The most essential factors concerned in the prevention of poultry mortality are: (1) well-bred stock; (2) adequate houses, management, and feeding; (3) proper sanitation; and (4) specific measures for the prevention and control of transmissible diseases.

Each obviously sick bird should be removed from the flock at once. If the symptoms are not recognized, all such birds should be killed and destroyed by burning, or submitted for diagnosis.[13]

Isolation quarters in which birds can be held for observation are

[12] For a complete discussion of poultry diseases and parasites see: Beach, J. R., and M. A. Stewart. Diseases of chickens. California Agr. Exp. Sta. Bul. 674:1–151. 1942.

[13] Specimens can be taken or sent to the State Department of Agriculture Laboratories at 1451 Mirasol Street, Los Angeles; Tenth and L Streets, Sacramento; 627 F Street, Petaluma; or to the University of California, Division of Veterinary Science, Berkeley. In shipping specimens the sender should: (1) be certain that the specimens selected are representative of the major illness in the flock; (2) send sick rather than dead chickens if a selection of representative specimens can be made on the basis of symptoms; (3) select dead chickens as soon after death as possible; thoroughly chill them in a refrigerator or by other means and wrap them in several layers of paper; (4) ship by prepaid express; (5) take the specimens to the express office just prior to the departure of a train that will ensure delivery to the person making the examination on the same day as shipped or in the morning after an overnight journey; (6) attach to the package in a sealed, stamped envelope a statement telling the age of the chickens affected, the size of the flock, the number already affected, symptoms shown by the sick, whether the same or similar condition has previously existed on the farm, and other pertinent information; (7) give the name and address of both owner and sender, if shipment is not made by the owner.

recommended, but they should be sufficiently removed from regularly used pens and yards so that birds in isolation will not be a source of danger to the main flock. In contrast, hospital pens are of questionable utility, because individual treatment of sick chickens is seldom justified. The time and effort required for such treatment and care can be more profitably employed in the proper management of the healthy birds.

Serious loss from pullorum disease, coccidiosis, roundworms, and other common chick ailments can usually be avoided by proper attention to preventive measures. Thus, all chicks should be from flocks that have been tested for pullorum disease and all reactors promptly removed. Moreover, no eggs from untested or reactor hens should be hatched in the same incubator.

All chicks purchased should come from clean hatcheries, be delivered in clean boxes, and be placed in thoroughly cleaned and disinfected houses with no contact between them and any older birds or any other birds that may be carriers of disease. Similarly, all visitors should be excluded from the pens, since they might introduce diseases or parasites.

Coccidiosis.—Coccidiosis apparently cannot ordinarily be excluded but can be controlled by sanitation. Keeping the litter dry by placing the water on low wire platforms, avoiding overcrowding, and reasonably frequent cleaning all help to control this disease. When an outbreak of coccidiosis occurs among floor-brooded chicks, it is advisable to clean the pens daily. Where coccidiosis is a serious problem, raising the chicks on wire will help. The wire should be kept clean and the attendant should not walk on the wire.

Roundworms.—This intestinal parasite can be controlled by keeping the birds off contaminated ground and by sanitation. Birds heavily infested with roundworms should be treated with nicotine preparations.

REARING PULLETS

Merely to hatch or purchase well-bred chicks and brood them properly will not guarantee maximum results in the laying house. Proper feeding and management during the rearing period are equally essential.

RANGE VS. CONFINEMENT

The comparative value of complete confinement, as contrasted with more or less free-range management in rearing pullets, is a disputed question. Certainly there is considerable opinion that optimum development in young stock can only be obtained with range conditions. This influence will not be evident, however, if adequate attention is given to proper nutrition and sanitation. Suffice it to say that each method is being successfully used by many producers in this state.

Where land values are high or not enough land is available to provide yards of reasonable size, many successful poultrymen confine their birds to houses at all times. The confinement method is often desirable when soil is extremely heavy and drainage is poor. Furthermore, the soil in small dirt yards surrounding permanent poultry houses may eventually become so contaminated, particularly with organisms such as roundworms and coccidia, as to force poultrymen to use continuous confinement methods.

Free-range management presumes a large acreage of land in proportion to the number of birds. The ideal range will have good soil so that green crops of value to the birds can be raised. There will be an adequate water supply available and an abundance of shade during the summer months. There will be cross fences so that a proper rotation of range can be practiced from year to year. Range shelters, as well as water and feed facilities, will be portable so they can be readily moved from one part of the range to the other. Such extensive acreage and facilities are available on few poultry ranches in California. For this reason, the greatest percentage of growing birds in this state are raised under systems of management that are intermediate between complete confinement and the more natural free range.

SIZE AND KIND OF YARDS

The most widely used management system provides a more or less limited outside yard of some kind for the use of the birds. These may be of dirt when reasonable acreage is available and soil types and drainage facilities make their use feasible. When acreage is more limited and when heavy or poorly drained soils are present, it is more customary to use small porches which may be of wire, slat, or concrete construction.

Dirt Yards.—It is possible for internal-parasitic infections such as roundworm eggs and coccidial oöcysts to remain alive in moist soil from one year to the next. For this reason, dirt yards should not be used for chickens without proper rotation or renewal. A double-yard system simplifies rotation and the two yards may be on the same or on opposite sides of the house.

Proper rotation, particularly of small dirt yards, is essential. If properly done it will accomplish the important dual purposes of inexpensively destroying all dangerous infections, and of utilizing surplus fertilizer which cannot otherwise be removed.

The first important step in the rotation process is to remove all birds and make certain that they stay out of the yard. The ideal time to start the rotation in California is in early summer when spring rains are

over. This is not always possible when the yards are being used to grow replacement stock. But it is the most ideal time.

The next step in a good rotation system is to rake up and cart away all excess droppings, feathers, and litter. Cut and burn all weeds, and make sure there are no puddles of water in the yard.

The third and most important step is to permit the sun to disinfect the soil. Dangerous disease germs and parasites, if any, are on or near the top of the ground. Do not waste money on sprays and disinfectants because the drying effect of strong sunlight is the best and least expensive topsoil disinfectant. Allow the yard to remain hard, dry, and bare as long as possible before plowing. If these organisms are plowed under immediately, they may be able to live in the moist soil for a year or more.

The final step in the rotation process should take place after the first good fall rain. That is the proper time to plow and seed to barley, wheat, oats, or some other fall- and winter-growing crop which will take advantage of rainfall and use the excess fertilizer in the soil. No crops should be grown that require irrigation or cultivation. Resulting green feed should be cut and fed while it is young and tender.

When spring rains are over and green crops begin to dry out, the yard will again be ready for use. It will be clean and relatively safe for birds of any age.

Wire Porches.—Wire porches are used extensively where satisfactory dirt yards are not practical. They may be made as described on page 12. Apparently even chicks can travel comfortably on ¾-inch-mesh wire, but 1-inch mesh may be more nearly self-cleaning for birds 3 months of age or older. The porch may be from 6 to 12 feet wide and should extend along the entire front of the house. It will prevent the birds from eating droppings and, therefore, aid in controlling roundworms and coccidia.

Wire porches have an advantage over hard-surfaced yards, particularly on hilly land. Their use eliminates necessary excavations and fills. If the frames are high enough aboveground the droppings can be cleaned away without moving the frames or disturbing the birds.

Concrete Yards.—Concrete yards 12 to 20 feet wide may be used where land is high priced and free range or suitable large yards are not available. (See figs. 4 and 6.) They may save land, but their primary value is to help control intestinal parasites. Their most practical use is limited to level land where excavation and leveling costs are not excessive, and they may be particularly desirable on heavy soils where drainage is poor.

Concrete yards should have a slope of at least 1 inch in 10 feet to insure drainage and to aid in cleaning. On level land such yards gener-

ally cost no more than hardware-cloth yards of similar size and usually are more durable. They are of questionable value, however, unless they are kept clean and dry.

Slat Yards.—Slat yards, or porches, are sometimes used as substitutes for wire yards. (See fig. 5.) They may be useful in sections where redwood is available at reasonable prices. The slats usually are 1 by 3 inch redwood and are spaced 1 inch apart on edge. The slats may be nailed to supporting joists to make portable sections and used to cover the yard area along the front of the house. If the nail holes are drilled before laying, no trouble will be experienced from splitting, and heavier nails can be used to prevent twisting. On hillside locations the sections may be placed on a permanent framework high enough to permit easy removal of droppings.

Slat yards are not always self-cleaning since the droppings will tend to adhere to the top edge of the slats. When properly constructed, however, they are sturdy enough to support the weight of an attendant who can quickly clean them with a scraper and broom. Slat yards, or porches, should be comparable in size to those recommended for wire or concrete runs.

FEEDING AND MANAGEMENT

The feed for growing birds is essentially the same as that needed by adult birds. It must contain all the essential nutrients of a complete ration, namely, carbohydrates, proteins, fats, minerals, vitamins, and water. Not only should the ration supply the various nutrients that are necessary, but it should supply them in the correct proportions. The proportional requirements for proteins, minerals, and vitamins are at the maximum during the first few days of the chick's life. With increasing age, however, the rate of growth diminishes, and so do the proportional requirements for protein, while the energy requirements (which are supplied primarily by starch and fats in the feed) increase.

Birds on free range ordinarily get enough sunshine to prevent rickets and provide for bone growth. They may pick up insects, worms, and greens to supplement the ration. Quite different are the conditions for birds in semiconfinement or complete confinement. Their opportunity to supplement the basal feed is limited and, therefore, special care must be exercised in providing a satisfactory ration.

All feed given to the birds should be fresh and clean. Grain, as well as mash, should be fed in hoppers or troughs—neither should be thrown on the ground.

To simplify management and reduce labor, the birds may have free access both to a mixture of whole grains and to dry mash continuously. (The practice with moist mash is discussed on p. 39.) Ideally, with dry

mash, a 24-hour supply should be put in the troughs every day—just the amount the birds will clean up before another daily supply is fed; this insures fresh mash at all times. With grain, in contrast, several days' supply may be placed in hoppers.

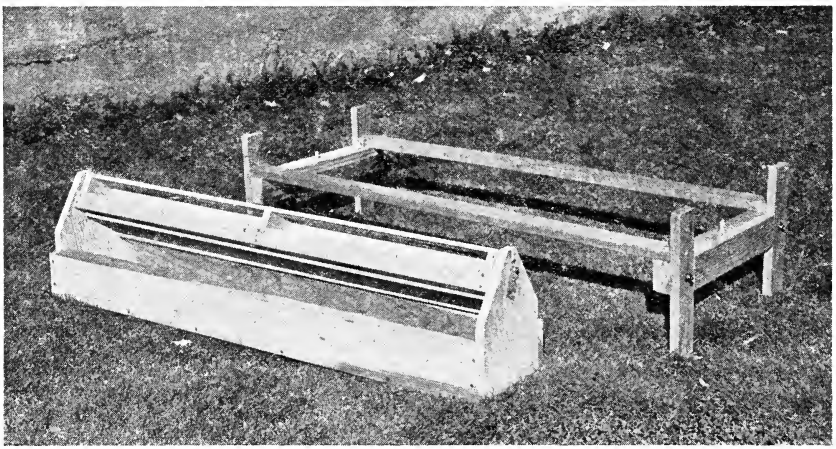


Fig. 12.—Intermediate-sized chick hopper with adjustable reel and platform. This size of hopper will care for chicks from 5 weeks to 6 months of age. For older chicks it can be placed on the platform, the legs of which are adjustable. This permits the hopper to be raised higher as the chicks grow larger. Note wing nuts on bolts and bolt holes in legs for adjusting height of legs. A narrower and shallower hopper of this type may be used for younger chicks. (From Bul. 476.)

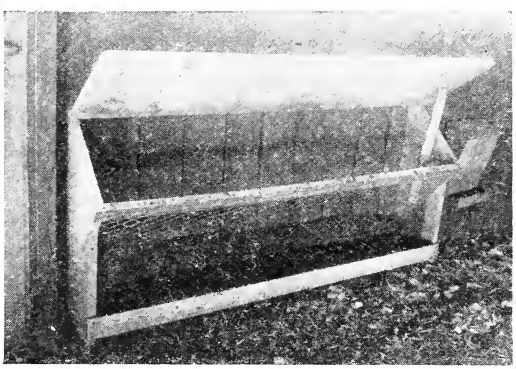


Fig. 13.—Wall-type green-feed hopper.
(From Bul. 476.)

Be sure that enough hopper space is provided so most of the birds may eat at the same time. Two troughs for mash and one for grain (each 6 to 8 inches wide and 6 feet long) should be provided for each 100 birds (fig. 12).

A daily supply of tender green feed should be placed before growing pullets. Even when ranging on green pasture, they will consume large

quantities of tender greens when it is finely chopped and fed in hoppers (fig. 13) or troughs. One hundred pullets approaching maturity in semi-confinement or complete confinement may eat as much as 5 or 6 pounds of chopped greens daily. It supplies essential bulk, vitamins, and minerals to the average ration.

The principles underlying adequate poultry nutrition, and practical rations designed to meet these requirements, are completely set forth in California Extension Circular 108.[14]

Good management is just as important as good feed. Many flocks of good pullets are ruined by improper management during the rearing period. Occasionally the damage is done by improper rations or rations composed of poor quality feeds. Most often, however, poor growth and development can be traced to crowded conditions in the houses or range shelters, lack of adequate feed hoppers and drinking facilities, insufficient shade in the yards, and the use of contaminated or unsanitary yards or ranges. Each of these poor management practices will tend to prevent optimum growth and development.

Anything a poultryman can do to make his birds more comfortable and encourage increased feed consumption will usually pay dividends in the form of better growth. Growing birds should be outside the houses as much as possible during good weather. Satisfactory shade at some distance from the house or range shelters will be used by the birds if feed and water facilities are provided in the shade (fig. 19). Distant shade, without feed and water provisions, tends to discourage rather than encourage feed consumption, particularly in warm weather. Water and feed should always be together. Feed, especially dry mash, at a considerable distance from drinking water is a very poor management practice. Furthermore, all feed should be in the shade, because exposure to sunlight rapidly reduces vitamin content.

Most poultrymen feed dry mash to growing birds. When the birds appear to lack appetite and do not eat a sufficient amount, a daily feeding of moist mash may be beneficial. This may be particularly true when a limited amount of skim milk is available. Moist mash for chickens should have a crumbly consistency, never sloppy. What the birds will consume in about 30 minutes is the correct amount. Any remaining after that time should be removed because moist mash can spoil quickly, particularly in warm weather, and may be harmful to the birds.

Dopes and tonics are not substitutes for clean, fresh feed and water. Furthermore, they are expensive and may be harmful rather than beneficial.

[14] Almquist, H. J., T. H. Jukes, and W. E. Newlon. Feeding chickens. California Agr. Ext. Cir. 108:1–41. Revised 1940.

DISEASES AND PARASITES OF YOUNG BIRDS

Certain poultry diseases, such as fowl pox and infectious laryngotracheitis, can be controlled by preventive vaccination. The use of such vaccines to immunize young birds against these diseases is recommended where either or both are known to have been present on the ranch during

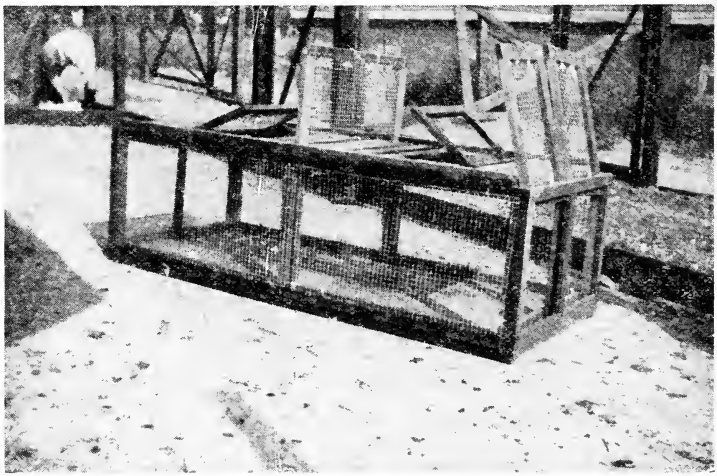


Fig. 14.—A catching crate, or coop, permits the convenient handling of the flock at all times. The removable drop partition between compartments aids in catching the birds. (From Ext. Cir. 28.)

the previous year. Young birds, however, should not be vaccinated unless they are in good health and in good physical condition.[15] Flocks which are in poor condition should not be vaccinated until they are again in good health. These vaccines are not recommended on farms in an isolated district on which neither disease has ever occurred.

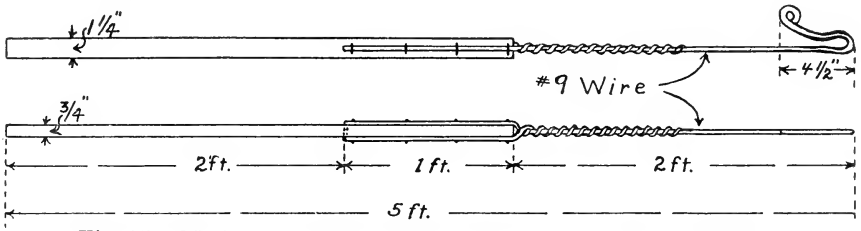


Fig. 15.—Method of constructing a catching hook. (From Cir. 268.)

GRADING AND SEGREGATION

During the growing period, certain birds in a given flock grow and develop more rapidly than others. These stronger, more precocious and domineering individuals tend to bully their weaker pen mates so that the

[15] For a complete discussion of poultry diseases and parasites, see: Beach, J. R., and M. A. Stewart. Diseases of chickens. California Agr. Exp. Sta. Bul. 674:1–151. 1942.

latter do not have the same opportunities, particularly at feed and water. When separated from the larger birds and given special feed and management, many of these backward birds, which under usual conditions are only culls, will have opportunity to develop into good

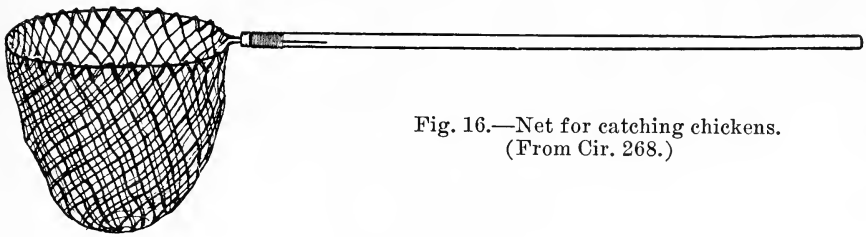


Fig. 16.—Net for catching chickens. (From Cir. 268.)

individuals. (See fig. 14.) Such segregations, based mainly upon size, weight, and development, are recommended at least twice during the growing period.

Segregation Out of the Brooder House.—It is desirable to separate cockerels from pullets just as soon as the sexes can be identified. This practice is generally completed at the time the birds leave the brooder houses. However, the segregation of the cockerels and pullets at this time into two or preferably three groups, each according to size and weight, is just as important as the separation of the sexes.

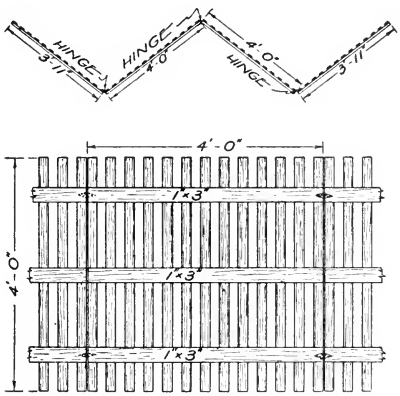


Fig. 17.—Plan for the construction of a catching panel. (From Bul. 476.)

This segregation permits special management of the males so that they may be rushed through to a marketable weight in the shortest possible time. It also provides opportunity to give the pullets more room and better care during the early part of the growing period. Various aids in segregating the birds are illustrated in figures 15, 16, and 17.

With cockerels that are to be sold as broilers, segregation may be taken care of more or less automatically as the larger birds are sold. Yet even with broilers, more uniform growth and a higher percentage of top-grade birds will be produced when the cockerels are segregated into two groups at the time they are removed from the pullets. This will also simplify the selection of the larger broilers for market when they attain desired weight.

Segregation of the pullets at 8 to 12 weeks (the earlier, the better)

according to growth and weight will tend to produce more uniform development and fewer runts and culls. This segregation can usually be made most conveniently just after the sale of the broilers. Such a practice provides necessary increased floor, roost, feeding, and drinking space, and thereby eliminates possible crowded conditions.

TABLE 8

PULLET SEGREGATION RECORDS, 409 FLOCKS, 206,419 SINGLE-COMB WHITE LEGHORN PULLETS 4 TO 6 MONTHS OLD*

Grade	Total birds each grade and group	Percentage of birds each grade and group	Eggs per bird	Mortality	Birds culled during year
	number	*per cent*	*number*	*per cent*	*per cent*
No. 1, early maturing	71,485	34.0	167.0	19.8	42.7
No. 2, medium maturing	96,262	47.0	159.7	22.6	54.2
No. 3, late maturing	38,672	19.0	.....	.....	.....
No. 3, sold at time of segregation	32,641	16.0	.....	.....	.....
No. 3, retained on ranch	3,031	3.0	121.4	42.4	78.6

* Original data collected by senior author from records of demonstration-flock owners coöperating with Agricultural Extension Service, 1921 to 1939, inclusive.

TABLE 9

RECORDS FOR 1,077 TRAP-NESTED SINGLE-COMB WHITE LEGHORN PULLETS, HATCHED 1936*

Grade	Total pullets in flock	Percentage in flock	Production index, eggs per pullet	Replacement (mortality and culls)
	number	*per cent*		*per cent*
No. 1, early	263	24.4	182.2	40.3
No. 2, medium	783	72.7	150.9	48.5
No. 3, late	31	2.9	62.8	77.4
Total	1,077	100.0	156.0	47.4

* Data from University of California, Division of Poultry Husbandry.

Growing birds should have all the feed they will eat, but care should be taken to see that none is wasted. Both grain and mash should be hopper-fed, and a generous daily feeding of tender greens is recommended.

Segregation into Laying House.—The second segregation of the pullet flock should be made when the birds are 4½ to 5 months of age. At this time they should be divided into three groups—two to keep and one to sell. See tables 8 and 9.

The exact number of pullets that qualify for each grade will depend upon the quality and development of the birds in the flock. Proper

segregation according to grade, however, is impossible unless the birds are all the same age and have had identical feed and management.

The no. 1 group should contain the earlier-maturing pullets because they will prove to be the most profitable producers. These should have well-developed combs for their age, long, deep bodies, and for Leghorns will approach 3½ pounds in weight. Undersized birds should not be included in this group because the standard[16] weight for 6-month-old Leghorn pullets is 4 pounds, and for mature hens is 4½ pounds. Records also prove that those birds which approach standard weight for the breed are likely to be better producers than those which fall much below or greatly exceed that standard.

These early-maturing birds must be fed generously in order for them to maintain body weight while producing heavily. Both grain and mash may be hopper-fed continuously. Good birds will not get too fat.

The medium, or no. 2, group will contain those pullets that have developed less rapidly. They will evidence good health, but both physical and sexual development will be less advanced. They need a little more time in which to reach full development.

These birds usually are less aggressive than the early-maturing birds, but may make good production records, particularly when segregated into groups of like size and quality. Feeding, care, and management should be the same as recommended for the previous group.

Group no. 3 will contain all backward, slow-developing birds which show no evidence of approaching production. It will include all runts and all sick or deformed birds. Such birds are culls and should be sold as quickly as possible. Records in tables 8 and 9 prove them to be unprofitable as producers.

PROTECTIVE DEVICES

Outbreaks of cannibalism among older birds can usually be checked or prevented by the use of various mechanical devices which are now on the market. Unfortunately, however, none of these are known to be infallible, because losses may occur in spite of their use.

Tipping the beak is also recommended to control severe outbreaks (fig. 18). The edge of the upper beak is cut in about ⅛ inch, ⅓ to 3/16 inch from the tip, according to the size of the beak and the length of the tip. Then by prying and pulling with the flat side of the knife, the point of the beak is removed by tearing and not by cutting. Thus the tip of the beak is removed to the quick so that it is tender for a while and is left in such shape that the bird cannot firmly grasp either feathers or flesh.

[16] American Poultry Association. American standard of perfection. 487 p. American Poultry Association, Fort Wayne, Ind. 1933.

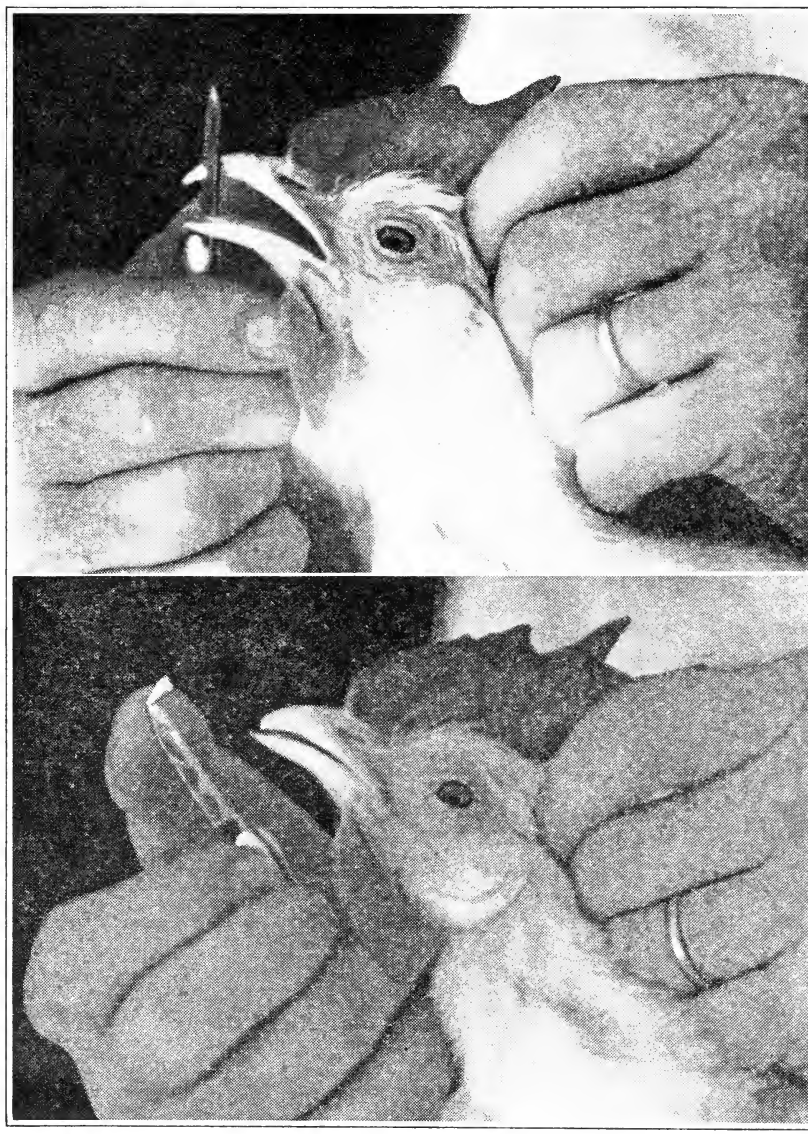


Fig. 18.—Tipping the beak to control cannibalism. Upper, Method of removing the tip of the upper mandible; lower, showing the piece removed and the upper mandible after tipping.

About 3 weeks is required for the beak to grow out again and by that time the habit is usually broken.

Work done at the Western Washington Experiment Station indicates that there is more feather picking when pelleted mashes are fed, and that there is less feather picking when rations high in fiber are fed than when rations are low in fiber. If an excessive amount of fiber is fed,

growth is decreased, presumably through lowering the birds' intake of digestible nutrients. Hence, there is a limit to the practical use of fiber, although a reasonable amount of wheat bran, alfalfa meal, and other bulky feeds should be included in the ration. The amount of alfalfa meal used should, however, be governed more by the birds' vitamin requirements rather than to supply bulk.

Observations in the field indicate that birds being fed a certain mash are more likely to develop cannibalistic tendencies when that mash is very finely ground than when coarsely ground. While the ration may be, and in many cases undoubtedly is, responsible for outbreaks of cannibalism, it is known that overcrowding, associated with an unfavorable environment and poor management, is the commonest cause of this vice.

REARING COCKERELS FOR BREEDING

The primary objective in rearing breeding cockerels is to provide the necessary nutritional and environmental conditions that will enable prospective breeding cockerels to attain optimum physical and sexual development. Each individual cockerel's ability to respond to favorable environment will depend upon his inherited characteristics, which are determined by breeding.

Numbers Required.—It has been found advisable to save at least three times the number of 8- to 10-week-old cockerels that will be needed as mature breeding males. In practice, this means holding a minimum of 20 Leghorns or 30 heavy-breed males for each 100 breeding hens to take care of expected mortality and necessary culling.

Selection and Culling.—The first selection of breeder cockerels is usually made before any broilers are sold. At this time selection should be based on rapid growth, early maturity, quick feathering, sturdy conformation, and robust health. The selected birds should have straight keels and strong bones, and be free from visible defects and disqualifications.

As these birds develop, it is wise to cull out all individuals that fail to grow properly, as well as those with noticeable defects. In this manner, even with Leghorn cockerels, many may be salvaged and sold as broilers or fryers before they become too staggy.

When heavy-breed cockerels are being developed, a second general culling and grading is recommended at 3 to 4 months. Each bird should be handled and carefully examined, particularly for slow development, defects, and faulty body conformation. Those saved as possible breeders should have a plump breast and full red comb and wattle development. This second culling among the heavy-breed birds will permit all off-grade birds to be marketed as fryers or small roasters.

During the growing period, all birds that have been completely beaten and subdued by their pen mates should be removed.

The final selection should always be made at the time the males are placed in the breeding pens. All breeding males used should approach standard[17] weight for the breed and be strong, vigorous birds. Many of the common defects and weaknesses are hereditary and therefore should be avoided whenever possible.

Feeding and Management of Breeding Cockerels.—Feeding and management practices are of primary importance in the development of breeding males. The birds should be comfortably housed in roomy, well-ventilated houses or range shelters. If flock mating is practiced, in which several males are to be used in the same breeding pen, it is essential that these males shall have been reared together in the same yard or pen. This will tend to eliminate much of the destructive fighting after the birds are mated.

Any good poultry mash, plus generous amounts of grain, green feed, and water, will take care of the feed requirements for cockerels during the rearing period. The birds should have access to each of these continuously. The feed and water containers should be more numerous than is generally recommended for a similar number of pullets. (See section on "Rearing Pullets," p. 34.) Furthermore, these containers should be widely spaced or scattered to permit the more timid males the opportunity to eat and drink. (See fig. 19.) When abundance of natural shade is not available for the birds, as well as for feed troughs and water, then artificial shade should be provided.

Pole perches, hurdles, and barriers of various kinds are recommended in the pens and on ranges. These will permit the more timid to elude aggressors and may save the lives of many cockerels.

Crops such as Indian corn or sunflowers are often grown in poultry yards to provide shade, protection, and supplementary feed. When either of these is grown in cockerel yards, however, it should be planted in rows rather than scattered. Furthermore, the stalks in each row should be thinned or spaced at least 6 inches apart. This will prevent birds from being chased about and then trapped and killed when trying to escape from other males.

Dubbing and Spur Removal.—Since California climatic and temperature conditions in all important poultry districts are such that frozen combs are not a problem, there is no evidence to indicate the necessity, or even the desirability, of dubbing the combs of breeding males.

In some sections, however, the presence of edema of the wattles justi-

[17] American Poultry Association. American standard of perfection. 487 p. American Poultry Association, Fort Wayne, Ind. 1933.

fies the dubbing of the wattles of breeder males. The equipment necessary for this operation is a table of convenient and comfortable height for the work of the operator, two Ferguson forceps or clamps (one for each wattle), one pair of curved scissors, and a supply of antiseptic astringent dusting powder. An assistant holds the bird securely while the operator stands directly before the bird. One clamp is fixed in position on each wattle, with the convex side of the jaw upward toward

Fig. 19.—An ideal cockerel range provides plenty of room and an abundance of shade.

the lower beak. When both clamps are securely fixed in the proper position, the wattles are removed by cutting as closely as possible along the ventral surface of the clamp with a pair of curved shears. Dusting powder is then applied to the wounds, pressure slowly released on the clamps, restraint removed, and the bird allowed to go back into the pen.

Complete spur removal is seldom necessary. If aged males are used, the spurs may easily be clipped with pliers or snips. This blunts the end of the spur and prevents injury to the hens. With heavy breed males, however, it is very essential to blunt the toenails. This should be done at the beginning of the breeding season and is easily accomplished by using pliers or a file.

REARING MEAT BIRDS

Most of the poultry sold for meat by California poultrymen are by-products of egg-production flocks, such as cockerels or cull hens and pullets. Certain poultrymen, however, derive all or most of their revenue

from the sale of Leghorn broilers or heavy-breed broilers, fryers, or roasters. Very few raise large roasters or capons.

Broilers differ from fryers or light roasters primarily in weight. In either case the object is to obtain rapid, economical growth so that the birds can be marketed at the earliest possible age. This facilitates the most efficient use of equipment and labor. The choice of stock, feed, equipment, and management all influence the results obtained.

ECONOMIC CONSIDERATIONS

Costs and Returns.—Surveys indicate that the margin of profit from rearing meat chickens is small. Costs and returns from Orange County, California, are given in table 10. These data differ from those obtained by surveys of broiler or fryer costs in other states principally in two cost items, namely: in cost of labor, which is higher, and brooder fuel, which is lower. In the enterprise-efficiency studies on which table 10 is based, it required about 3,000 hours of labor per 10,000 chicks, or one man to each 2,500 to 3,000 birds on hand. With efficient labor and equipment one man should be able to handle at least twice this number. The lower fuel costs in California as compared with those in some other states are perhaps due partly to a milder climate, partly to lower prices per unit of fuel.

Feed is the largest cost item per pound of chicken raised. The cost of feed per pound of chicken depends on the price of feed and the amount of feed consumed which, in turn, depends on the age and weight at which they are marketed, and mortality. Mortality and the age at which it occurs affects all costs. Chicks are the next highest item of cost, with labor third, while all other items made up less than 10 per cent of the total cost (see table 10).

Over a period of years, meat production as a specialized branch of the poultry industry has been less stable than commercial egg production. The fluctuations in profits are illustrated by the much lower income per pound in 1939 than in 1940. When margins of receipts over costs are low, only those who receive a better-than-average price, or those whose costs are lower than the average, are able to stay in business.

According to the Orange County enterprise-efficiency study, the capital investment is $2,500 per 10,000 birds raised, which is low. Limited capital, however, is often a handicap in this business. Many who start are unable to increase their operations to the point where they can raise enough birds to provide an adequate income. In some cases, labor efficiency, in particular, could be much increased by a higher investment in better equipment. In other cases, better equipment and more careful layout of the plant are required to save labor.

Seasonal Effects.—There are seasonal variations in the market price of eggs and in the fertility and hatchability of the eggs set. These variations are reflected in the cost of chicks. Similarly, brooder-fuel costs will usually be higher in the colder winter months than at other times

TABLE 10

COSTS, FACTORS OF COST, AND RETURNS IN RAISING MEAT CHICKENS IN ORANGE COUNTY, CALIFORNIA*

Item	1939	1940
Average cost of chick, in cents	10.7	10.8
Average number of chicks	10,065	11,424
Per cent mortality	16.1	11.6
Average selling weight, in pounds	2.8	3.2
Pounds of feed:		
Per pound of poultry produced	4.2	4.2
Per bird raised	11.8	13.4
Costs and returns per pound of poultry produced		
	cents	*cents*
Costs:		
Total feed	8.9	8.9
Chicks	4.6	3.9
Labor	2.9	2.6
Fuel for brooding	0.2	0.3
Depreciation	0.4	0.4
Interest on investment	0.5	0.4
Other miscellaneous costs	0.3	0.3
Total per pound	17.8	16.8
Less manure and such income	0.4	0.7
Net cost per pound	17.4	16.1
Returns:		
Selling price per pound	18.9	19.6
Management income per pound	1.5	3.5
Farm income per pound	3.4	5.7

* Shultis, Arthur, and Ross E. Crane. Second annual Orange County poultry meat cost study, 1940 6 p. California Agr. Ext. Serv. 1940. (Mimeo.)

of the year. The market price of small Leghorn broilers tends to be lowest in April to July, inclusive; for large Leghorn broilers the price paid is usually lowest in May, June, and July. Prices paid for colored fryers fluctuate relatively less, but are usually highest from March to June, inclusive.[18] The variations in one year do not correspond strictly to those in another year; hence it is unwise to vary the output according to average seasonal trends in prices. For one thing, prices cannot usually be accurately predicted, and in the second place, the economic use of equipment and labor requires the continuous operation of the plant at or near its maximum capacity.

[18] Tinley, J. M., and E. C. Voorhies. Economic problems affecting poultry marketing in California. California Agr. Exp. Sta. Bul. 642:109. table 25. 1940.

BREEDS AND CROSSBREDS

The stock purchased, whether a purebred or crossbred, will depend partly on market preferences for birds with a particular plumage color and partly on whether broilers or fryers are to be raised. Surplus Leghorn cockerels are used extensively to produce light broilers and to some extent to produce heavy broilers. Crossbreds from Leghorn hens mated to males of some of the heavy breeds, such as the New Hampshire, the Single-Comb Rhode Island Red, the Barred Plymouth Rock, the Cornish, and other heavy breeds, are also used.

Fig. 20.—Differences in feathering and size of birds of similar age (about 9 weeks). The bird at the left and that at right are about the same weight.

The Leghorn and crossbreds from Leghorn × heavy breeds should not be used to produce birds weighing more than 2½ pounds. They usually make relatively inefficient gains after attaining this weight. The heavy breeds, such as the Plymouth Rock, the Rhode Island Red, the New Hampshire, or crossbreds from these breeds or of females of these breeds mated to Cornish males, are usually used for fryer or light-roaster production. Breeds and varieties such as the Jersey Giant, Australorp, and others may be used also when suitable strains are available. Black-plumaged fryers are less attractive when dressed than fryers of breeds that have fewer black pinfeathers; hence, fully black varieties should not be used unless exceptionally good strains are available.

A lower price is generally paid for white than for colored (plumage) fryers. For this reason, White Wyandottes, White Plymouth Rocks,

and other white-plumaged heavy breeds are little used for fryer production in California. The White Plymouth Rock male may be crossed with females of colored heavy breeds to produce barred fryers.

Different strains vary considerably in average rate of growth, in rate of feathering, and in fleshing. (See figs. 20 and 21.) The source of stock is therefore important. Early-feathering strains are now available in most of the popular heavy breeds—New Hampshires, Rhode Island Reds, Plymouth Rocks. Chicks should be obtained from such strains whenever possible. For crossbreeding it is highly desirable that at least one of the breeds used be out of an early-feathering strain. The parent stock should have been pullorum-tested and all reactors removed. Furthermore, the parent stock should have been selected for rapid growth, early feathering, and good fleshing qualities, since good breeding is just as important in the production of meat birds as in those used for egg production.[19]

Fig. 21.—Differences in feathering of birds at about 9 weeks of age.

HOUSES, YARDS, AND EQUIPMENT

The houses used for rearing or finishing broilers or fryers are similar to those used for raising pullets. When floor-brooded, the birds can be kept in the same houses until ready for market, or they can be moved to other similarly built houses. In summer, open sheds may be used. Such houses are used by some to brood the chicks, particularly in the southern part of the state, but provision is usually made to cover the front temporarily in cold, wet, or very windy weather. Such makeshift fronts help to keep down the cost of the house but require more labor to ensure good results. The cheaper brooder and rearing houses often have dirt or sand floors which are changed to a depth of 2 or 3 inches after each lot is marketed. Others have concrete or wire floors. The most efficient type to use will depend upon local conditions.

The use of yards varies from free range to none. When yards are used every effort should be made to keep them free from disease-producing parasites and other organisms. If small dirt yards are used, they should either be left vacant at intervals by having two sets of yards, or the top 2 or 3 inches of soil should be removed and replaced with clean sand

[19] Asmundson, V. S., and I. M. Lerner. Breeding chickens for meat production. California Agr. Exp. Sta. Bul. 675:1–45. 1942.

or soil after each lot is marketed. The alternative is to use concrete, wire, or slat porches.

Chicks may also be reared in batteries of several different types: (1) unheated multideck batteries housed in much the same way as other commercial batteries used for starting chicks (see p. 22); (2) single-tier batteries, best described, perhaps, as unheated outdoor-type brooders with an enclosed box at one end of a wire runway. Such batteries usually have 1-inch-mesh floors with waterers and feeders on the sides and ends. Some batteries allow several inches of head space, while others are made just high enough for the birds. Where the latter type is used, it is necessary to give the birds more head room as they grow. The runways may or may not have roofs, and the roofs may be removable or fixed. Roosts 2 by 3 inches are usually laid flat on the wire. These batteries are at varying heights above the ground. Concrete platforms under the batteries facilitate removal of the droppings.

MANAGEMENT OF MEAT BIRDS

In practice, the floor space per bird varies. The minimum suggested is shown in table 3 for birds raised in batteries, and in table 2 for birds raised on the floor.

There is an increasing tendency to start broiler or fryer chicks in commercial multideck batteries for the first 7 to 14 days. Some remove the chicks on the twelfth day to allow 2 days for cleaning and disinfecting the batteries and fumigating the room between broods. The brooding is then continued under floor brooders or in outdoor brooders. Some operators move their birds into larger batteries (single-tier type) every 2 or 3 weeks. This necessitates moving the chicks a total of four or five times. Moving the chicks is considered more economical and better practice than allowing more space at first or building equipment that is larger than needed for chicks of a particular age. Frequent moving may have additional merit if the equipment is cleaned and the birds segregated for size and weight each time they are moved. However, frequent moving of the chicks undoubtedly reduces labor efficiency. The equipment and houses should be thoroughly cleaned and disinfected each time chicks are moved out and before other chicks are moved in. (See fig. 22, *A* and *B*.) If the chicks are not moved frequently, then cleaning should be done whenever necessary, preferably once a week except in locations where the droppings dry out very rapidly. Waterers should be cleaned daily; feeders should likewise be cleaned regularly.

FEEDING MEAT BIRDS

Broilers and fryers are usually started on an all-mash feed with a little grain fed for a varying period before the birds are marketed.

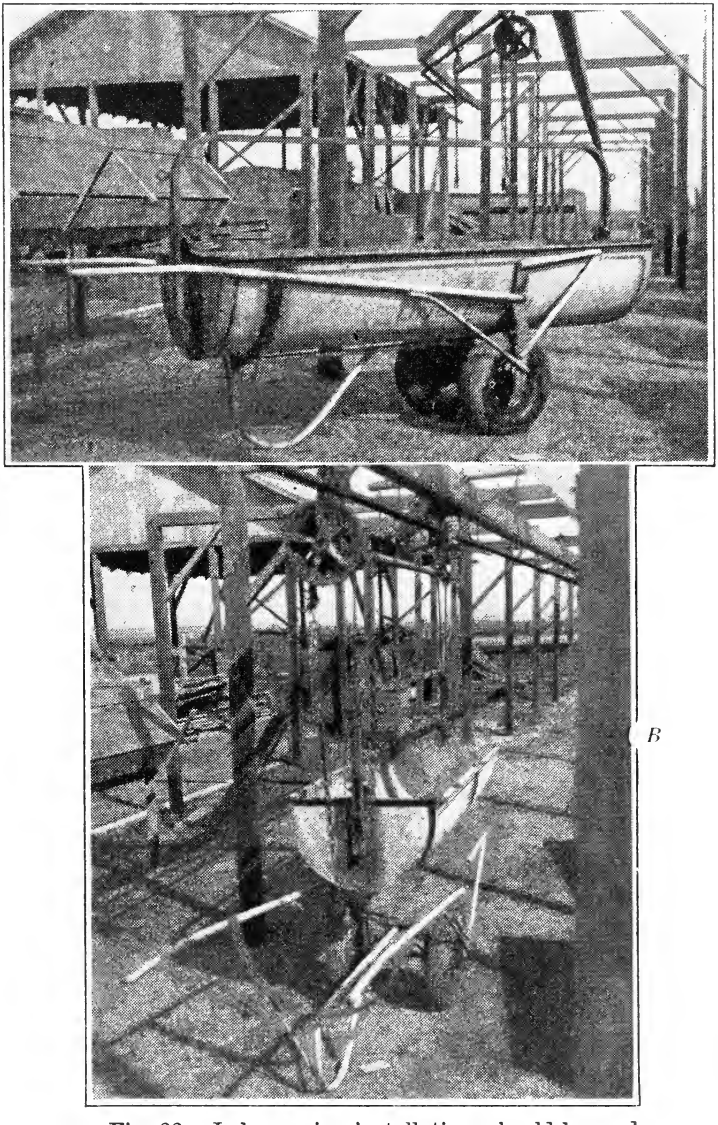


Fig. 22.—Labor-saving installations should be used wherever possible. *A*, Cart with galvanized-iron box let down on it is used for cleaning the pens. *B*, The box is then lifted off the cart and taken by carrier track to manure shed in the background.

Heavy mash consumption tends to promote rapid growth. Rate of growth and feed consumption are shown in table 11. The data in table 11 also show that the more rapidly growing heavy-breed birds utilize feed more efficiently after the first few weeks than the slower-growing Leghorns.

TABLE 11

WEIGHTS OF SINGLE-COMB WHITE LEGHORNS AND NEW HAMPSHIRES AT DIFFERENT AGES AND THEIR FEED CONSUMPTION

Age in weeks	White Leghorns						New Hampshires‡		
	Males*			Females†			Males and females		
	Average weight of bird	Average feed consumed to date	Feed per pound of bird to date	Average weight of bird	Average feed consumed to date	Feed per pound of bird to date	Average weight of bird	Average feed consumed to date	Feed per pound of bird to date
	pounds	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
0	0.087	....	....	0.087	.....	....	0.087	.....	....
2	0.261	0.375	1.44	0.203	0.28	1.38	0.196	0.311	1.59
4	0.563	1.252	2.22	0.478	1.00	2.09	0.435	1.087	2.50
6	1.139	2.813	2.47	0.886	2.35	2.65	0.908	2.352	2.59
8	1.718	5.208	3.03	1.383	4.10	2.96	1.630	4.853	2.98
10	.....	.....	....	—§	5.50	—	2.220	7.716	3.48
12	.....	.....	....	—	7.30	—	2.948	11.249	3.82
14	.....	.....	....	—	—	—	3.650	15.360	4.21
16	.....	.....	....	1.980	11.90	6.01	4.083	19.201	4.70
18	.....	.....	....	—	—	—	4.618	22.833	4.94
20	.....	.....	....	2.540	16.90	6.65	5.075	26.212	5.16
22	.....	.....	....	—	—	—	5.355	30.479	5.69
24	.....	.....	....	3.130	22.40	7.16	5.620	34.518	6.14

*Unpublished data from Division of Poultry Husbandry, California Agricultural Experiment Station. The birds were kept in batteries.

† Adapted from: Almquist, H. J., T. H. Jukes, and W. E. Newlon. Feeding chickens. California Agr. Ext. Cir. **108**: 1-41. Revised 1940.

‡ Data from: Tepper, A. E. Growth and feed standards for New Hampshires. New Hampshire Agr. Exp. Sta. Cir. **52**: 1-8. 1937.

§ Dashes indicate data not available.

VICES AND BLEMISHES

Cannibalism and feather picking are common vices among broilers and fryers, particularly under crowded conditions. For that reason, the chicks should be carefully watched and prompt action taken to check these vices before they develop into serious outbreaks (see p. 31).

Breast Blisters.—Breast blisters are commonly observed on birds raised on wire. These defects occur on heavy-breed males, while relatively few Leghorns or heavy-breed females are affected. Roosts placed in batteries help to reduce the incidence of breast blisters, but evidence

is not sufficient to show that the use of other management practices, such as deep litter, have any effect on the incidence of breast blisters. There may be inherited differences in the tendency to develop breast blisters but the evidence is inconclusive. Since most breast blisters develop after the birds are 15 weeks old, the problem is more serious in birds grown to a weight of over 4 pounds.

Bone Defects.—Bone defects sometimes occur among broilers and fryers. These include crooked keels, crooked backs, and perosis. *Crooked keels* are likely to be due to improper mineral balance, not enough vitamin D when the birds are deprived of sunshine, or both. Early roosting on narrow roosts aggravates the tendency to develop crooked keels.

Crooked backs may be caused by vitamin-D deficiency aggravated by other factors, including crowding. Vitamin D thus apparently plays an important part in preventing these abnormalities. Feeding excessive amounts of vitamin-D-potent oils or other vitamin-D carriers does no good. Moreover, large amounts of fish oils may cause off-flavors, particularly if fed up to the time the birds are marketed. If oil containing 400 units of vitamin D per gram is fed, adequate amounts can be supplied without change of flavor.

Perosis, or slipped tendon, is also characterized by bowing of the legs and enlarged hocks. It is caused by a deficiency of manganese, of choline, of biotin, and possibly of other organic factors, and is aggravated by an excess of calcium or phosphorus. It is seldom a problem unless extra calcium in the form of oystershell or limestone is fed in addition to a properly formulated ration. Hopper feeding of extra bone meal may also increase the incidence of perosis among growing chicks.

Nutritional factors are mainly responsible for these common abnormalties. Faulty management may increase their incidence. Moreover, there are inherited differences in the tendency to develop crooked keels and perosis; hence, the birds with these or other abnormalities should never be used for breeding.

GRADING AND DISPOSAL

Not all birds reach the same weight at the same age. Thus, some birds of the heavy breeds reach a weight of 3½ pounds at 11 weeks; the average age at this weight may be about 13 weeks, while some birds lag 2 or 3 weeks behind the average. Because of this variation, it is advisable to grade the birds according to size whenever they are moved. Since the slowest-growing birds do not always make economical gains, it may be better to market some of these at lower weights than those at which fryers are ordinarily sold.

Uniform growth up to market age undoubtedly depends upon breeding, but even more on good management. Correct temperatures during the brooding period, enough room for the birds, plenty of feeding and watering space, and regular care to see that the birds have feed, water, and do not crowd, are all important in helping to secure uniform rapid growth.

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